ELECTRICAL WORLD

A consolidation of Electrical World, Electrical Engineer and American Electrician

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What in the World!

Induction heating of energy-conducting material has no rival for speed. Bringing a 1-in. in diameter steel rod 4 in. long from room temperature to forging temperature in two to three seconds is an example. A razor blade manufacturer who needed to show quality to purchasers and profits to stockholders has tried the inductive heat-treating method and saves $9,000 a year in fuel costs alone (p. 252).

●

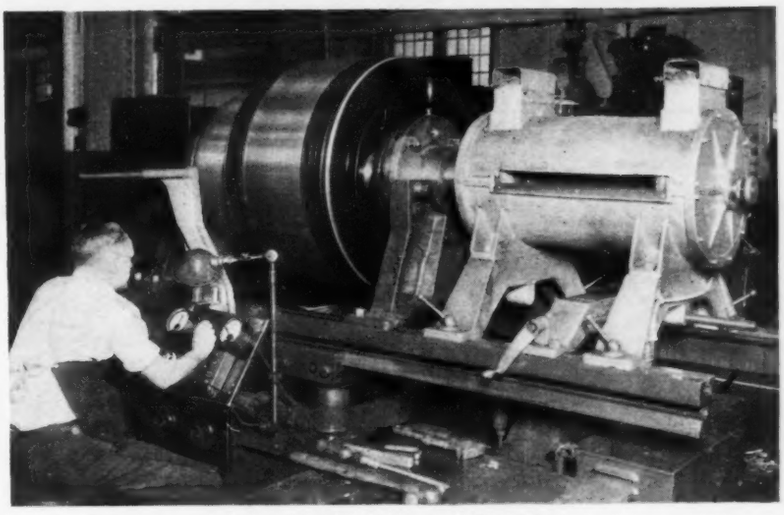
They seem to be mostly dry-eyed mourners, these lamenters of the passing of N.E.L.A. One can't help wondering if something hasn't been lost, in the spirit of co-operation that was built up through many years of effort, in not more rapidly achieving a policy for perpetuating committee work and the encouragement of local organizations to carry on where the passing of N.E.L.A. left a definite void (p. 242).

●

Secondary metering of primary services brings obvious economies in the cost of the installation, but it means a compromise of economics and ideals as to metering accuracy. Philadelphia Electric has solved the problem in a way highly satisfactory when all factors are given full weight and consideration. Standard meters, but special compensation to allow for transformer losses, are necessary (p. 260).

●

It has been estimated that but one bill out of 1,200 introduced for possible action by our legislative servants reaches enactment. It's probably too many, at that. But what if the mills of the demagogues ground out even a few of those pending on utilities? (p. 244).



Dynamic armature balancing at Westinghouse

FEBRUARY 25, 1933

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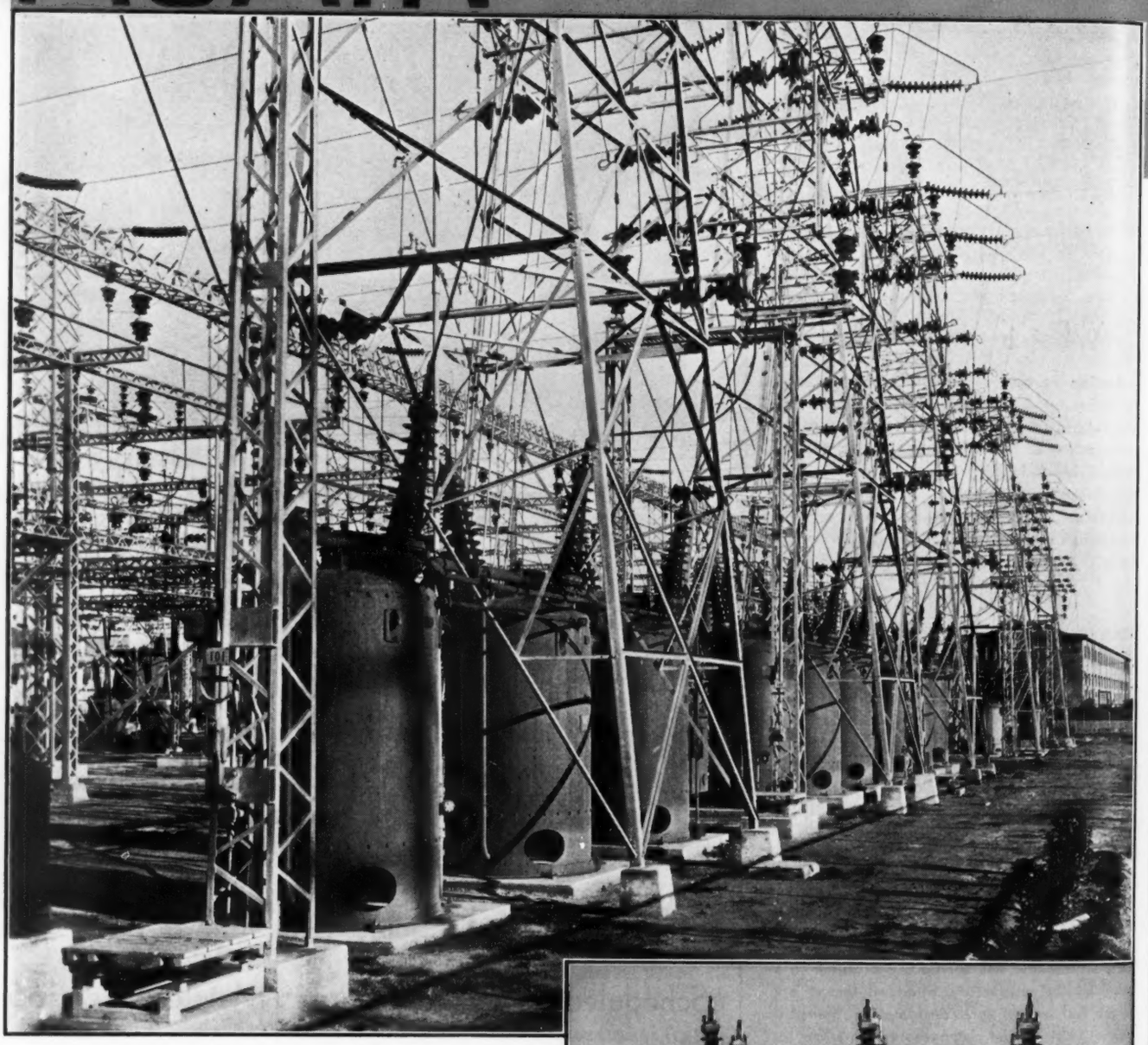
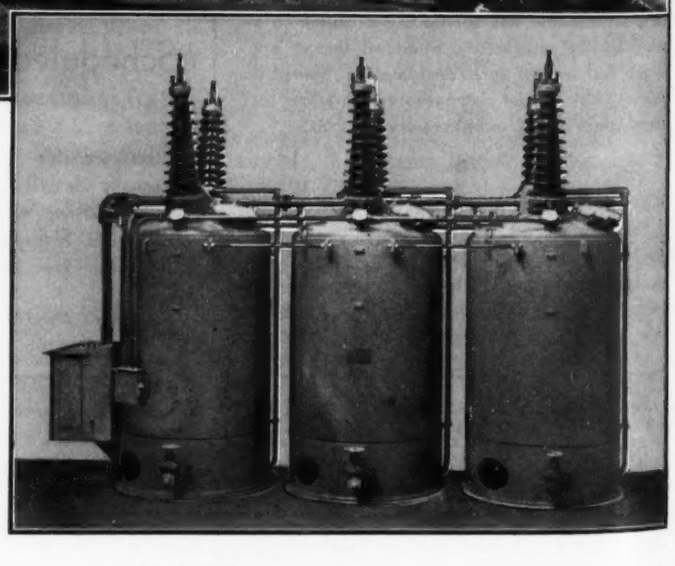
AGAIN "DE-ION GRID



The Martin Substation on the Pacific Gas and Electric Company's system. In the foreground are the two Westinghouse, Type GO-1, 115-kv. "De-ion Grid" Oil Circuit Breakers which required no maintenance even after continuous service of 14 and 26 months, respectively.



The new GO-2, 138-kv. "De-ion Grid" Oil Circuit Breaker with improved welded tank contruction.

ELECTRICAL WORLD

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for the Week Ending

February 25, 1933

Committee Approves St. Lawrence Pact

BY A VOTE of fifteen to five the United States Senate foreign relations committee voted this week to report favorably upon the St. Lawrence water-way treaty.

The favorable report is counted upon by friends of the treaty to smooth its course in the Senate, though leaders are said to agree that a Senate vote on it was unlikely until the special session.

Senator Walsh of Montana, probably Attorney-General in Mr. Roosevelt's Cabinet, has backed the treaty and requested the committee vote.

Only fourteen of the 22 members of the committee attended the meeting this week, and these divided eight for the treaty and five against it, with Senator Reed not voting. Those supporting the treaty were led by Senator Borah, chairman of the committee.

As a favorable report required that a majority of the entire committee vote for it, Senator Borah polled the absentees after the meeting, seeking three more votes and finding seven.

▼

Detroit Edison Co-operated in Michigan Moratorium

"Our business is going along as usual and in fact the whole business of the community seems to be running about the same," said A. C. Marshall, vice-president and general manager Detroit Edison Company, in response to a query as to how his company was affected by the eight-day closing of banks in Michigan, February 14-22, on an emergency order by Governor Comstock. Mr. Marshall continued:

"The company has suffered no serious inconvenience from the bank holiday. We have been compelled to make a few changes in operating methods, the most important being a temporary agreement to cash our employees' pay checks. We arranged to get currency from New York and are now cashing these checks at all our offices and at some other locations.

"We also immediately agreed to extend the discount periods so no customer would lose his discount by being temporarily unable to pay his bill. This arrangement was later embodied in an order from the state utilities commission. Payments of bills are coming in about as usual, but with a larger percentage of checks instead of cash. The slower accounts that we usually have to send out collectors for are a little slower than usual."

▼

Northwest Association Will Continue Its Activities

Dissolution plans of the National Electric Light Association have caused but slight change in the organization and scheduled activities of the Northwest Electric Light and Power Association for the balance of the association year, ending June 30. The association will continue its committee studies and reports and will hold its three customary section meetings: Accounting, Engineering and Sales. The principal change in plans is for holding the Sales Section conference in Portland, March 30 to April 1, instead of in Spokane, March 16-18, as originally announced. This will be the first of the three to be held, the others being tentatively scheduled in Portland—Engineering in April and Accounting in May.

The Northwest association does not need to undergo a major operation to cease functioning as a geographic division of the N.E.L.A. and to continue its activities after the dissolution of that body. It was formed as an independent association in 1908 and did not become officially a geographic division until 1921, though it maintained an informal relationship with the N.E.L.A. from 1911. Through all its 25 years of existence, even since 1921, it has maintained its autonomy and has carried on its affairs under its original name and not as the "Northwest Geographic Division." Other local divisions closely linked with N.E.L.A. have a similar status.

The future of the association after June of this year has not been determined. A strong sentiment exists in some quarters for its continuance on some basis, and this subject will be given consideration at a meeting of the executive committee, March 30, 1933, to be held in Portland.

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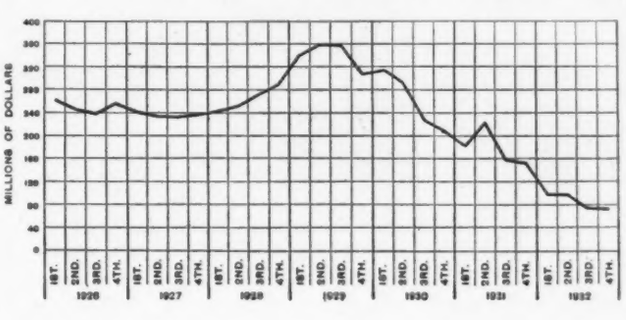
Has Electrical Manufacturing Hit the Bottom?



That resistance levels are being established in some significant indexes appears reasonable. Will further changes be improvements? This chart, compiled by the Bureau of the Census, reflects the orders booked by 84 electrical manufacturers.

Edison Electric Institute Prepares for Active Work

Now that the National Electric Light Association has taken the necessary formal steps to insure its dissolution (ELECTRICAL WORLD, February 18, page 209) progress toward the active career of the newly organized Edison Electric Institute is getting under way. At the meeting of the board of trustees of the institute, held in New York on the day following the N.E.L.A. dissolution convention, the roster of officers for E.E.I. was completed and an operating committee, virtually a governing committee, elected.

As previously announced (ELECTRICAL WORLD, January 14, page 49) George B. Cortelyou, president of the late N.E.L.A., will be president of the E.E.I. Vice-presidents, selected last week, are: Bernard F. Weadock, former executive director of N.E.L.A.; Paul M. Downing, Pacific Gas & Electric Company; A. H. Kehoe, United Electric Light & Power Company; P. S. Young, Public Service Corporation of New Jersey, and William J. Hagenah, Standard Gas & Electric Company.

The operating committee

Twelve members compose the operating committee which will direct the activities of the institute. Mr. Cortelyou will be chairman of the committee, which includes: James E. Davidson, Nebraska Power Company; B. J. Denman, United Light & Power Company; Alfred H. Schoellkopf, Niagara-Hudson Power Corporation; E. W. Lloyd, Commonwealth Edison Company; W. C. Mullendore, Southern California Edison Company; J. F. Owens, Oklahoma Gas & Electric Company; H. C. Blackwell, Union Gas & Electric Company; George W. Clifford, Engineers' Public Service Company; Sidney Hosmer, Edison Electric Illuminating Company of Boston; Horace Liversidge, Philadelphia Electric Company, and T. A. Kenney of the Commonwealth & Southern Corporation.

It is expected that at an early meeting of this committee measures will be undertaken to initiate the career of E.E.I.

▼

Senate and Trade Commission Continue Insull Company Investigations

DATA from the past and suggestions for the future mingled in the investigations of the Insull collapse independently but contemporaneously conducted by the Senate banking and finance committee and the Federal Trade Commission last week. Samuel Insull, Jr., continued his testimony (reported in part in ELECTRICAL WORLD, February 18, page 211), and Owen D. Young and Charles G. Dawes testified at the Senate committee hearing. Commission examiners and economists presented the data submitted to the Trade body.

Owen D. Young, testifying as to his part in General Electric's loan of $2,000,000 to Insull, confessed to a feeling of "helplessness" before the ramifications of the Insull structure. "I think it is impossible for any man, however able," said Mr. Young, "really to grasp the real situation of that vast structure. We should try to work toward the objective of having these structures simplified. I think Samuel Insull was very largely the victim of the complicated structure that he created." Mr. Young further conceded that he thought it impossible for any one to work out an accounting system for the Insull group which would not be misleading even to directors and concluded that since the complexities of his creation were incomprehensible to Mr. Insull himself, "how could the public which purchased the securities" be expected to comprehend it?

It is important "in these sensitive times," concluded Mr. Young, that nothing be done to disturb the existing business structure more than is necessary, but the ultimate aim should be for a simplified corporate structure and for full publicity for investors, perhaps required through federal law.

As to the loans which General Electric made to Mr. Insull, Mr. Young said that he was more concerned with "the effect upon business of the collapse of the Insull companies than he was with the $2,000,000 loan. Anything that would impair the credit of the Insull companies would impair their buying power and they were among the best customers of General Electric."

Testimony by Charles G. Dawes had largely to do with the banking policy involved in the granting of loans to Mr. Insull, it being contended that the Central Republic Bank & Trust Company, of which Mr. Dawes was chairman, had violated the spirit of the law in lending more than 15 per cent of its capital and surplus to companies of the Insull group.

It was agreed by Mr. Dawes that loans by the Central Republic to Insull companies, if taken as a whole, would amount to nearly 50 per cent of the bank's then combined capital and sur-

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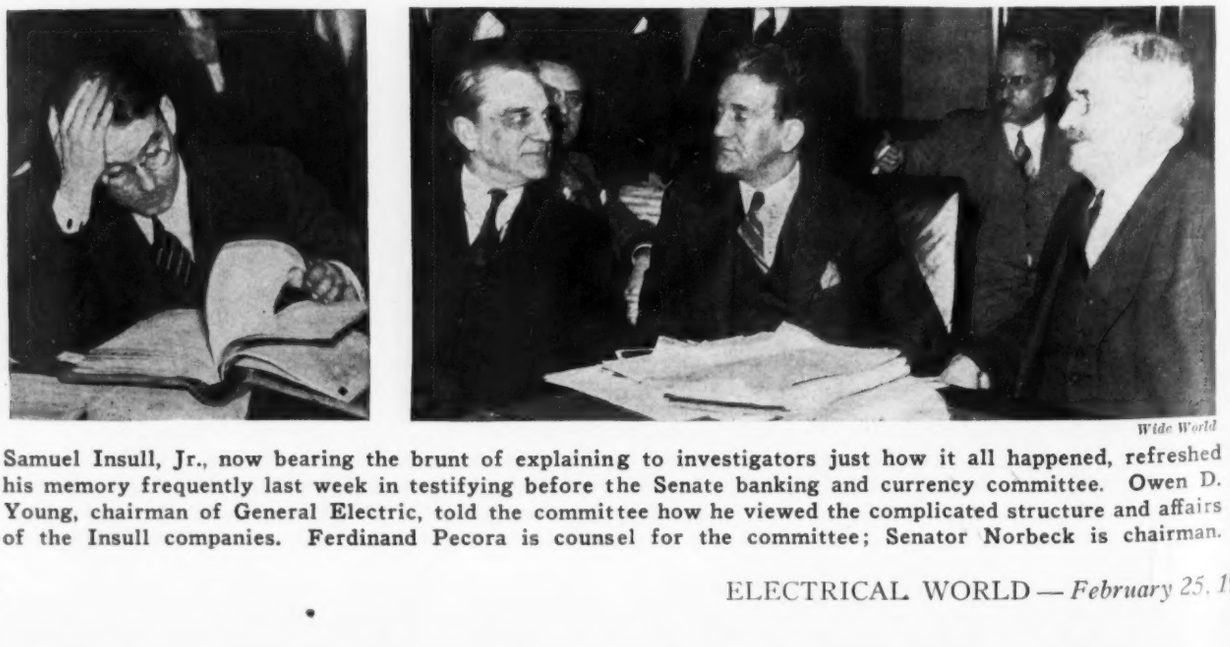
When the Senate Tackled the Insull Case



Wide World

Samuel Insull, Jr., now bearing the brunt of explaining to investigators just how it all happened, refreshed his memory frequently last week in testifying before the Senate banking and currency committee. Owen D. Young, chairman of General Electric, told the committee how he viewed the complicated structure and affairs of the Insull companies. Ferdinand Pecora is counsel for the committee; Senator Norbeck is chairman.

plus and added: "I think a feeling of sadness should come over any bankers who had a part in the negotiation of loans to the Insull utility companies."

Insull, Jr., again testifies

Resuming his testimony, Samuel Insull, Jr., was questioned concerning the interlinking corporate relationships of the various companies of the group and consulted freely with company records in making his replies. Mr. Insull was unable to state how many companies were included in the group, conceding that while he was an officer in all seven of the primary groups and an officer or director in fifty of the companies in the groups he could not state how many were operating companies and how many were investment or holding companies.

Insull banker has suggestion

Harold L. Stuart, president of Halsey, Stuart & Company, distributors of Insull securities, told the committee that he was "leaning toward" advocating a plan whereby utility securities would be offered for sale at public auction by the utilities commissions of the various states instead of being marketed in the present fashion.

With the Federal Trade board

That the Corporation Securities Company had a deficit of $103,327,000 when it went into receivership was told the Federal Trade Commission by W. H. England, its assistant chief economist. Assets at that time were but $13,000,000, said Mr. England. Most of the testimony of the Trade Commission examiners centered around the formation and balance sheet values and equities of the various Insull companies.

Other developments

Among the miscellaneous developments of the week in Insull affairs were: Election of W. W. Wheelock as a trustee of Insull Utility Investments, Inc., by the creditors after Federal Judge James H. Wilkerson virtually disqualified Calvin Fentress for that position; indication that the affairs of Middle West Utilities are more likely to proceed to bankruptcy and liquidation than to the prolongation of the receivership or to reorganization; announcement in the annual reports of the Commonwealth Edison Company and Public Service Company of Northern Illinois that Samuel Insull, Jr., has resigned as a director, member of the executive committee and vice-chairman and is now assistant to the chairman (Commonwealth directors were in the dark as to the buying of the company's own stock and discontinued the practice when this became known to them) and unofficial statements by bankers that Samuel Insull's $18,000 a year pension would not, contrary to rumor, be discontinued.

All Eyes Turn to Washington

Repercussions from the Michigan banking situation have dragged prices and trade volumes down so that the gains which followed the nation-wide cold snap have been lost. Both security and commodity prices have been notably weak. Figures for carloadings rose, but the latest available are, unlike energy production reports, subject to delay.

Marked increase in currency circulation took place last week, due in part to nervous hoarding, but in the major part influenced by the measures taken to relieve the Michigan situation with money from other districts. Gold is being earmarked for overseas accounts once more as foreign apprehension over our possible, but not probable, incursion into a major policy of inflation is mistrustfully surveyed abroad.

Fragmentary reports of the private discussions between the British Ambassador, Sir Ronald Lindsay, and President-elect Roosevelt indicate that something more than the provincially national attitude may be introduced into the debt negotiations by both sides.

Automotive production figures have taken a turn for the worse following the labor troubles in Detroit and are said to reflect manufacturing delays rather than declining sales.

Passage of the Eighteenth Amendment repeal resolution by the House and Senate and early votes by the states upon repeal ratification stir a new succession of hopeful, illusory thoughts in the minds of the public. However illusory the practical business gains to the country through the repeal of the prohibition amendment may be, it should not be lost sight of that Washington is the psychological key to a change in sentiment and to a possible turn to renewed confidence which may be founded on the shallowest of realities, yet work the wonders that ever spring from intangibles to confound the world too - firmly - engrossed with facts and figures.

Depression Factors Told in Boston Edison Rate Case

Resuming its hearings upon the petition of various consumers of the Edison Electric Illuminating Company of Boston for a downward revision of that utility's rates (ELECTRICAL WORLD, December 31, 1932, page 870) the Massachusetts Department of Public Utilities heard witnesses tell how the depression had upset the plans for and estimates of future loads and generating station requirements.

"If," said Counsel Ives of the Edison Company, "some one told us when the contract was made that this depression was coming on we would never have made the contract and New England Power would never have built Fifteen-Mile Falls." At the time that the contract was made, said Mr. Ives, it was considered wise and full consideration was given to the rights and position of the domestic consumer.

Upon the 1932 report of the Edison company did most of the discussion center at these resumed hearings. It was shown that the percentage of return on the capital invested was in 1932, 6.7; in 1931, 6.87; in 1930, 7.04; in 1929, 6.91; in 1928, 6.47.

Over the objections of counsel for the company, ex-Senator Mulhern of the petitioners' counsel sought to prove that 274,217,296 kw.-hr. were sold in 1931 under the free lamp service for which the company was allowed ½ cent per kw.-hr. for furnishing the free lamp service. This would give the Edison company $1,371,086. Assuming, Mulhern said, the cost of rendering the service to be $515,464, which statement the company objected to (stating that there were certain other costs which should go in), it meant that the Edison company received $855,621 for furnishing free lamp service.

▼

Oregon Senate Approves Utility Regulatory Law

Drafted by the state's one-man Public Utilities Commission, Charles M. Thomas, and introduced into the Oregon Senate last month, the new utility regulatory law was passed by that body February 10 after a stormy session. As finally amended and passed it provides for the recapture of excess earnings to be disbursed for the benefit of customers, assesses the cost of investigation to the utility, gives the commissioner supervisory control of operating and construction budgets and permits his supervision of security issues, sales, mergers and fees to holding companies (ELECTRICAL WORLD, February 4, 1933, page 149).

Two provisions in the original bill were stricken out by amendment, namely, a provision for declaring a utility official "in contempt of the commission" and a prescription of the methods and practices of accounting for depreciation.

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Fires Fought with Light

Beaumont, Tex., not only uses water and chemicals in its municipal firefighting but insists upon light as being a necessary aid. A special truck equipped with sixteen floodlights, some of which may be raised and lowered on telescopic standards, has been provided. Portable and fixed lights of Westinghouse design total 11.5 kw.

Coming Meetings

Electric Utility Engineers of New England—Boston, Mass., March 2-3. O. A. Bursiel, 20 Providence St., Boston.

Oklahoma Utilities Association—Oklahoma City, Okla., March 7-8. E. F. McKay, 1020 Petroleum Bldg., Oklahoma City, Okla.

National Sales Section, N.E.L.A.—Committee meetings, Chicago, March 21-23. A. J. Marshall, 420 Lexington Ave., New York.

National Engineering Section, N.E.L.A.—Committee meeting, Detroit, Mich., April 3-7. A. J. Marshall, 420 Lexington Ave., New York.

Maryland Utilities Association—Baltimore, Md., April 21. D. E. Kinnear, 803 Court Square Bldg., Baltimore, Md.

Missouri Association of Public Utilities—Excelsior Springs, Mo., April 27-29. N. R. Beagle, 101 West High Street, Jefferson City, Mo.

Electrochemical Society—Montreal, Que., May 11-13. Colin G. Fink, Columbia University, New York.

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Additional Utility Bills Introduced in Legislatures

Introduction of additional measures to effect public utility legislation continues in the Legislatures in the various states. Important ones additional to those reported February 11, page 180, and February 18, page 212, are:

ALABAMA—Would grant cities of 100,000 population authority to construct or acquire water and electric plants. Would reduce all classes of utility rates 25 per cent.

INDIANA—Would amend public service commission law to base valuation of public utility properties used and useful upon current, fair cash value. Would limit preferred stock and indebtedness of a utility to 75 per cent of total capitalization.

MINNESOTA—Would withdraw from sale all state-owned lands containing water-power sites suitable for commercial purposes. Would prohibit any building of dams or power sites that would change water levels of lakes or streams on state lands in St. Louis, Cook and Lake counties unless approved by the State Legislature.

MISSOURI—Would compel utilities to pay same rate for school taxes as is paid by real and personal property, a levy which would result in the utilities paying into school funds between $1\frac{1}{4}$ and $1\frac{1}{2}$ million dollars additional revenue annually.

OKLAHOMA—Would authorize cities to impose occupation and inspection tax on utilities.

OREGON—Would authorize state to develop power system by acquiring lands, waters, rights-of-way and building of plants and lines through issuance of general obligation bonds up to constitutional limitation, at present $65,000,000.

TEXAS—Would authorize cities and towns to establish electric and telephone rates, utility having right to appeal to Railroad Commission if not satisfied. Would impose tax on one-fourth of 1 per cent of gross income of utility companies to defray expenses of enforcing law.

WASHINGTON—Would extend jurisdiction of Department of Public Works over rates and all exchanges of water and power between various utilities. Would give department control over credits and charges to depreciation and all reserve accounts, authorization to regulate all issuance of securities and would require department's approval before common-stock dividend payment. Would grant department authority to control relations and practices between operating companies and their holding companies. Would eliminate present rule that valuation for rate-making purposes shall not be considered in connection with valuation for taxation purposes. Department would have right to assess all or any part of costs of rate and valuation proceedings back to utility involved. Would require utility companies to file annual budget of proposed expenditures in advance, expenditures being subject to approval of department. Would require utilities to keep merchandising business separate from public utility functions. Would prohibit utility companies from requiring employees to buy stock or to solicit sale of stocks of any holding companies during regular hours of employment.

WEST VIRGINIA—Would authorize the development of the water-power resources of the state through formation of a "Power Authority of West Virginia," consisting of five trustees, with authority to develop, maintain, manage and operate hydro-electric power plants and sale and distribution of electricity in that state.

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Hartford Electric Light Reports 1932 Operations

(Year Ended December 31)

Earnings	
Gross earnings	$6,670,572
	7.4% below 1931
Net earnings	$2,243,408
	9.1% below 1931
Operating ratio, same as last year	47
Depreciation allowance	$583,231
	8.7% of gross earnings
	2.2% of fixed capital
Times prior charges earned	417
	in 1931, 1,660
Net balance per share of common	$2.85
	in 1931, $3.12
Dividends declared on common	$2,303,267
	in 1931, $2,322,127

Output		Per Cent
Energy output, kw.-hr.	323,333,000	—12.4

Balance Sheet		Compared with 1931 per Cent
Total assets	$31,432,163	+1.7
Funded debt		
Capitalization	$21,000,000	Same
Total surpluses plus reserves	$8,819,690	+5.2
Ratio current assets to current liabilities		7.7
	in 1931	9.7

Price range of common $56 to $36 in 1932. Current price of $54 is 18.9 times 1932 earnings.

Great Lakes Power Club Votes to Continue

After acting affirmatively on the motion that its own organization should continue, the Great Lakes Power Club at its meeting in Chicago, February 17, expressed the majority opinion of those in attendance in two further resolutions, one in favor of a regional organization to carry on the work of the now defunct Great Lakes Division, N.E.L.A., and the other that some means be found to carry on the valuable activities of the national power sales committee.

The greater part of the meeting was given over to a discussion of municipal plant competition. A significant point brought out by W. J. Kyle was the need for a better understanding among utility people of the motives back of municipal ownership agitations which will permit them coolly and intelligently to work against such projects when they arise.

New officers elected are H. S. Richmond, Consumers Power Company, chairman; L. C. Shelain, Central Illinois Electric & Gas Company, vice-chairman, and P. W. Romig, Wisconsin Public Service Corporation, secretary.

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New England Engineers May Replace N.E.L.A. Division

Letter ballots have been mailed to all class A, D and F company members of the New England division of the National Electric Light Association to obtain voting sentiment as to the establishment of a new regional organization following the decision of the national body to dissolve.

At a recent meeting of the executive committee of the New England division a unanimous vote was passed in favor of forming a new association for the New England states, the question of name, scope and size of annual budget being included in the questionnaire ballot mailed to about 180 class members at the order of the committee. As yet only a few replies have been received, probably because of the absence of executives or necessity of action by directors' committees.

Pending actual dissolution of the national body, it is too early to determine what relationship, if any, a new group might establish with the Edison Institute, but widespread sentiment exists in New England in favor of carrying on the constructive work of the past through committee activities and in other ways.

Those engineering groups formerly affiliated as committees of the New England division of N.E.L.A. engineering section will meet in Boston March 2 and 3. These were the dates scheduled for sessions as part of N.E.L.A.

and with some changes in program the meeting will be held under the chairmanship of F. D. Knight of the Edison Electric Illuminating Company of Boston.

▼

Commissioner Fitzgerald Denounces Michigan Board

"Despite the fact that I went to Lansing in 1931 fortified by nearly twenty years intimate contact with public affairs," said Commissioner Edward T. Fitzgerald of the Michigan Public Utilities Commission, in a special statement issued last week, "I was so naive as to believe that regulatory bodies, such as the Public Utilities Commission, existed for the purpose of safeguarding the rights of the public. Regardless of all contentions to the contrary, it is my belief that municipalities, instead of being aided in the struggle for justice in the matter of rate regulation under the present system, actually encounter serious and sometimes insurmountable obstacles.

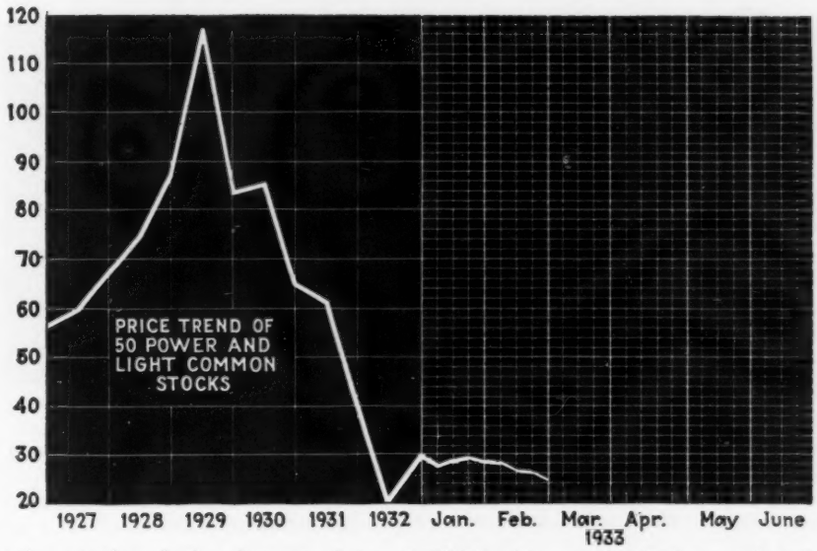
"After nearly two years' experience on the commission, I am further convinced that there is virtually no regulation of utility rates in the state of Michigan. In a perfunctory way, and in accordance with the law, financial reports are filed at stated periods with the commission by the corporations, but there is no thorough-going examination of these reports to determine whether the ratepayers are receiving a fair shake and it is only when a municipality appeals to the commission for action, that it is aroused at all from its lethargy.

Commission report challenged

"Although the Michigan commission in its annual report makes a claim to the contrary, there have not been more than one or two genuine reductions in utility rates ordered by the utilities commission at Lansing during the last two years, regardless of the fact that the price of every other known commodity has taken a downward course. It is true that the commission, in ex parte proceedings totaling perhaps 50 or 60, appears to have obtained concessions for the public. As a matter of fact, in nearly every instance the so-called 'reductions' have been in the nature of a 'bone' tossed to the public—a sedative, as it were, to quiet down the demand for substantial rate reductions which might result from a conscientious audit and appraisal.

"The truth is, that these inconsequential decreases were agreed upon between the utility and some subordinate in our office and were then submitted for the signature of the commissioners without even a discussion," contended Commissioner Fitzgerald. The commission has been divided for some time.

Stocks Continue Decline



Stocks continued the downward trend which characterized the market last week following the complicated banking situation which arose in Michigan, all leading issues losing considerable ground. The "Electrical World" index receded to 25.0 from 26.0 in the preceding week.

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Pennsylvania Inquiry Reorganized; Bill Pends

Reorganized under the chairmanship of Senator John J. McClure, the Pennsylvania Senate utility investigating committee has asked an additional appropriation of $46,000 to bring to a conclusion the work halted in December by court orders. About $53,000 has been expended to date to sift the senational charges of Governor Pinchot as to the shortcomings and failures of the state regulatory body. The late W. D. B. Ainey was chairman of the commission whose work is in dispute.

Senator McClure, who is also chairman of the recently appointed subcommittee of seven of the Senate committee on judiciary general, will probably bring a measure of peace to troubled waters. A bill sponsored by Senator McClure and introduced for consideration in a "sincere effort to prevent continuation of the evils disclosed" by the Rial investigating committee has been explained by Senator McClure and would:

1. Vest the Public Service Commission with broad power to suspend all increases in rates pending investigation into their reasonableness and propriety and to prevent those which it disapproves.
2. Require all public service companies to carry proper and reasonable depreciation accounts.
3. Vest the commission with jurisdiction over the issuance of stock and other securities by public service companies.
4. Vest the commission with jurisdiction over transactions between holding companies and public service companies. The bill also gives jurisdiction over financial transactions and management and supervisory contracts of various kinds with holding companies.
5. Vest the commission with certain jurisdiction over holders of more than a given amount of voting capital stock of public service companies.
6. Establish provisions regulatory of the business of manufacture, sale or leasing of appliances and equipment by public service companies.
7. Create a people's counsel bureau in the Department of Justice to represent communities which desire to complain against the rates imposed by and practices followed by public service companies.
8. Impose additional penalties on public service companies and their officers and directors for violation of any of the provisions of the law.

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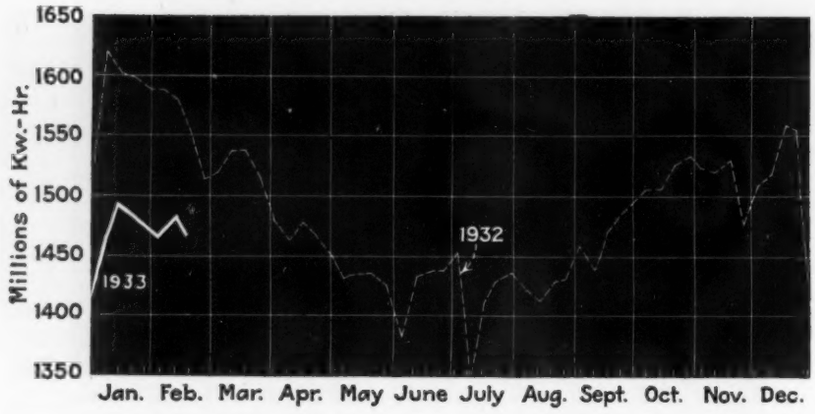
Commonwealth Edison Issues 1932 Report*

(Year ended December 31)

Earnings	
Gross earnings	$74,401,095
Net earnings	$16,903,038
Operating ratio	77
Depreciation allowance	$7,746,376
	10.4% of gross earnings
	2.5% of plant investment
Times prior charges earned	2.0
Net balance per share of common	$6.24
Dividends declared on common	$10,105,447
Output	
Energy output, kw.-hr.	3,686,440,000
Maximum load, kw.	855,000
Average use per customer, kw.-hr.	4,149
Balance Sheet	
Total assets	$462,237,175
Funded debt	$195,781,000
Capitalization	$364,702,800
Total surpluses plus reserves	$66,260,412
Ratio current assets to current liabilities	1.2

*Includes Commonwealth Subsidiary Corporation.

Output Closer to 1932



Energy output of electric light and power plants during the week ended February 18 approached closer to the production in the corresponding week of the preceding year than at any other time since the beginning of 1932. The 1,469,732,000 kw.-hr. represents a decrease of 4.9 per cent. In the week before the disparity was 6.1 per cent; on that occasion the improvement from the previous 8.4 per cent could be ascribed in part to heavy storms. The further gain now reported seems to indicate actual, if slow, progress.

Regionally, conditions on the Atlantic Seaboard are about as they were in the week of February 11, although New England considered by itself registered a gain. So did the Pacific Coast region. In the Central industrial area the disparity is 10 per cent less than it was in midsummer.

Weekly Output, Millions of Kw.-Hr.

Week Ended	1933	1932	1931	1930
February 18	1,470	1,545	1,680	1,746
February 11	1,483	1,579	1,684	1,770
February 4	1,455	1,589	1,679	1,782
January 28	1,470	1,589	1,687	1,809
January 21	1,484	1,598	1,713	1,826

Per Cent Change from Previous Years

Region	Week Ended Feb. 18	Feb. 11	Feb. 4
Atlantic Seaboard	— 4.6	— 4.2	— 7.8
New England alone	— 5.1	— 5.7	— 8.1
Central industrial	— 6.9	— 6.5	— 11.0
Pacific Coast	— 7.0	— 8.4	— 8.8
United States	— 4.9	— 6.1	— 8.4

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Small Heating Unit Sales Specialized by 112 Utilities

Extensive acceptance of its "Midget" load-building plan (ELECTRICAL WORLD, October 29, 1932, page 598) by utilities is reported by the General Electric Company, which also submits evidence of the extent to which small electric heating devices and units are being adopted by the customers of utilities using this plan. During the months of April-July, 1932, it was presented to 138 utilities and up to the close of that year 112 had accepted it. Although 75 per cent of the acceptances were in New York, Mid-Atlantic, East Central and Central divisions of the United States, there were 28 acceptances elsewhere, including the Southwest and Pacific coast, where competition with oils and natural gas would be expected most severe. Seventy-one of the companies are using 150 sample kits to show customers the versatility of applications and 30 more kits are being employed by dealers, jobbers, etc. Fifty-seven utilities are using the General Electric's direct-mail campaign to customers and paying the postage thereon.

As to results, 40 companies which had averaged three months application of the plan had added 4,580 kw. in small heating devices, or at the rate of 450 kw. per company per year. In 70 companies reporting, 152 men are used on this campaign, or about 2.2 per company. But in most instances they were not additional men, but those engaged in less active power-sales work and transferred to this compaign. Many still devote a portion of their time to other power sales work.

This rate of acquisition of new business is equivalent to $18,000 annual revenue per company, General Electric Company calculates. As the men become more experienced it is expected that the same number will sell more kilowatts.

▼

Big Canadian Merger Links Manufacturers

What is said to be one of the biggest amalgamations ever to be effected in the Canadian electrical manufacturing industry has been negotiated and will be made effective April 1. The merger is of the Canadian branches, all long established, of four outstanding English electrical engineering firms. These are: Lancashire Dynamo & Crypto Company of Canada, Ltd., Bruce Peebles (Canada), Ltd., Harland Engineering Company of Canada, Ltd., and Crompton Parkinson (Canada), Ltd.

The new Canadian firm will be known as United Electrical Engineers, Ltd., with head office in Montreal and a branch in Toronto. It will continue the manufacture of general electrical equipment and machinery previously carried on in parallel by the subscribing firms. All obligations, contracts and commitments of the previous firms will be absorbed by the new business.

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Gas and Oil to Dominate, Mining Engineers Are Told

Predicting that the use of oil and gas for energy production will double within the next twenty years, while the use of coal for that purpose will continue to decrease, W. Spencer Hutchinson of the Massachusetts Institute of Technology and August J. Breitenstein of the Philadelphia & Reading Coal & Iron Company reported upon an energy survey of the coal and petroleum industries to the winter convention of the American Institute of Mining and Metallurgical Engineers this week.

Thirty years ago, the report states, 91 per cent of the country's developed power came from coal and only 4 per cent from oil and natural gas. In 1930 the power from coal dropped to 60 per cent, while that from oil and gas had risen to 31 per cent. By 1950, it is estimated that coal will be furnishing only 46.6 per cent, gas and oil 45.3 and water power 8.1 per cent.

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First Billion Kw.-Hr. Record Established in Great Britain

Not until 1932 did any single power generating enterprise in the United Kingdom achieve an output of 1,000,000,000 kw.-hr. in a year. The record is that of the London Power Company, which, despite continued national depression in which the electrical industry of Great Britain has suffered little, generated 1,008,264,304 kw.-hr. There were 27 companies in the United States in 1931 with an output of more than 1,000,000,000 kw.-hr. Niagara Hudson topped the list with nearly 6,000,000,000. Figures for 1932 are not yet available.

In reporting upon his company's operations, Sir Francis Fladgate, chairman, showed that operating costs in 1924 were 1.10 cents per kilowatt-hour, in 1931 0.436 and in 1932 0.406. Capital charges were 1.94 cents per kilowatt-hour in 1926, 1.12 in 1931 and 1.06 in 1932.

Oil Burner Sales Show Declining Trend

Compared with 1931 the number of domestic oil burner units using forced draft shipped last year declined 21 per cent. In the case of industrial units the decline was but 17 per cent. Figures reported to the Bureau of the Census by 103 manufacturers and covering only those machines shipped for use in this country and of the mechanical draft type show:

	1930	1931	1932
Domestic	71,434	60,133	47,830
Industrial	9,732	5,778	4,810

August, September and October account for nearly half of the yearly totals as shipped, so the summer months and early fall appear to be the best time to push this attractive power load for the electric utilities.

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Arizona Wins Allocation of Hoover Dam Water

Under a contract offered to the state of Arizona 2,800,000 acre-feet of main-stream water would be delivered from the Colorado River and Hoover Dam, it is announced by Secretary Wilbur of the Department of the Interior. Thus apparently ends a long and bitter fight by the state to participate in or forestall the Hoover Dam development. Negotiations between California and Arizona for allocation of the main-stream waters had previously been unsuccessful. Arizona has until now insisted 2,800 000 acre-feet of main-stream water plus one-half of any excess to be its share. The contract would be between the state and the federal government.

Under the proposed contract the disposal of any water left in excess of the amounts provided for would be left to future negotiations which are specified to be unprejudiced by the agreement.

Arizona's opposition to the Hoover Dam plan began years ago. After construction was started the state attacked the constitutionality of the act of Congress which authorized the project, but was over-ruled by the Supreme Court.

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Detroit Edison Ranges Rented to Employees

For rentals of either $1 or $1.50 per month, according to the choice of electric range selected from the two available, the Detroit Edison Company now offers kitchen ranges to its employees. The rental contract infers no obligation to purchase, but one-half of the sum of rentals paid will be credited on purchase if the employee decides to buy at any time.

The only time stipulation in the contract is that rentals will be paid in for one year in order partially to protect the company's investment, which includes the cost of installation as well as the cost of the range. After the first year the rental contract may be terminated if the user then desires.

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Refrigerator Sales Push Ordered by General Electric

Announcement of a nine-week national sales campaign, said to be the most aggressive so far planned by General Electric, to begin April 3, has been made.

Presumably based upon the conviction of T. K. Quinn, vice-president, that "there will be an upward trend in the spring, the forces of repair and reconstruction are quietly at work now." General Electric is to make every effort to obtain its share of refrigerator sales.

According to P. B. Zimmerman, general manager of the appliance sales and refrigeration departments, General Electric remains loyal to the policies of sales specialists, closed territories and "leads" through kitchen exhibits.

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Will Direct Current Serve for Future Transmission?

Definitely predicting that electrical energy transmission of the future depends upon high-voltage direct-current systems, C. W. Stone, consulting engineer General Electric Company, told a meeting of the Metropolitan Section of the American Society of Civil Engineers last week that "we have approached the limits of the voltages which can be used on underground cables with alternating currents, but with direct current the voltage limit is not yet in sight."

Pointing to the work of Thury, the European engineer, in developing his system of direct-current transmission and to the use of sixteen such installations abroad, varying in length from 12 to 248 miles and in voltage from 2,600 to 100,000, Mr. Stone stated that upon gas-filled electron tubes of the phanotron or thyratron types which may be used as converters or inverters does the probability of development rest (ELECTRICAL WORLD, March 14, 1931, page 488).

Economies and advantages

Advantages of direct-current transmission as pointed out by Mr. Stone lie in: Assured stability of the transmission system, frequency of the a.c. services to user may be varied to any desired, absence of capacity effects, freedom from dielectric losses, greatly reduced insulation requirements and over-all economies.

Citing three cases for a possible 300,000-kw., 300-mile, 300,000-volt, three-phase, 60-cycle system to consist of two lines, each capable of transmitting the full power, Mr. Stone showed that against losses of 30,000 kw. with a.c. the losses with three alternative d.c. plans would be 10,260 kw., three-wire, or 20,520 kw., three-wire with the same size conductor, but 15,340 kw. with a larger conductor and two wires.

In the case of an existing 13,200-volt underground system it was pointed out that with a.c. 10,000 kw. was the maximum power which could be transmitted, while under d.c. operation at 20,000 volts the same system would carry 36,000 kw.

Developments, according to Mr. Stone, await the realization of "a real demand" before becoming commercially practical. The current capacity of the gas-filled electron tubes so far produced is a limiting factor.

Major New Construction This Week

Consumers Power Company, Jackson, Mich., will spend $2,000,000 for extensions and betterments in transmission and distributing lines, meter installations, etc., as well as purchase of substation equipment

Until March 1, Bureau of Reclamation, Denver, Colo., asks bids for three, four or five 115,000-hp. vertical shaft hydraulic turbines and one or two 55,000-hp. turbines for Hoover Dam. (Specification 540.)

Motors, controls, transformers, electric pumps, compressors and loading equipment will be installed in new plant at St. John, N. B., of Gulf Refining Company. Cost about $700,000.

Rockford, Iowa, plans early call for bids for equipment for city-owned electric light and power plant. Fund of $105,000 has been voted.

Platte Valley Reservoirs Association, Gothenburg, Neb., plans hydro-electric generating plant in connection with water project on North Platte River, near Sutherland, Neb. Cost over $1,000,000 with transmission line.

Motors, controls, etc., will be installed by Buffalo Woolen Mills, Worthington, Pa., rebuilding after fire. Cost about $100,000.

New Standards Approved

Approval by the American Standards Association has been given to new standards and specifications for shaft couplings of the integrally-forged type for hydro-electric units, impregnated paper insulation for lead-covered power cable and illuminating engineering nomenclature and photometric standards.

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New York Metal Prices

	Feb. 14, 1933 Cents per Pound	Feb. 21, 1933 Cents per Pound
Copper, electrolytic	5.00	5.00
Lead, Am. S. & R. price	3.00	3.00
Antimony	5.75	5.75
Nickel ingot	35.00	35.00
Zinc, spot	3.00	2.95
Tin, Straits	23.70	23.60
Aluminum, 99 per cent.	23.30	23.30

Manchester (Conn.) Electric Upheld

Refusing to accede to the request of a group of 150 petitioners that the rates of the Manchester Electric Company be reduced, the Connecticut Public Utilities Commission has once more blocked the path of Albert Levitt, long-time contender against the commission on various utility rate and policy matters. The commission found that: "The Manchester Electric Company is not legally warranted in reducing the rates now in force and that . . . the company is exceptionally well managed, economically operated and renders a high standard of service."

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To Re-establish Group Drives

Under the name of Mechanical Power Engineering Associates, manufacturers of various items of equipment used in industrial group drives are endeavoring to re-establish this form of power application wherever it is economically feasible.

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Rate Cut for Baltimore

Consolidated Gas, Electric Light & Power Company of Baltimore has agreed to voluntarily reduce its rates for electricity, effective June 1, in the area of Baltimore and vicinity. An annual saving to domestic and small commercial customers of at least $550,000 is foreseen. The use of 50 kw.-hr. costs $2.63, as compared with $2.50 under the new schedule, while the use of 100 kw.-hr. under the old schedule cost $4.48, against $4.18 under the new schedule.

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Chicago "Sky-Ride" to Be Welded

Foremost among the spectacular features of the Century of Progress Exposition, and comparing thereby with the great Ferris wheel of the first Chicago World's Fair, the Sky-Ride that will shoot visitors across the lagoon in a rocket car is to be extensively electrically welded. The two main towers will require approximately 19 miles of automatic welding and about 3½ tons of welding wire.

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Sioux City Settles Out of Court

Compromise between the Sioux City (Iowa) Gas & Electric Company and the City Council effects a reduction of $466,000 annually in gas and electric cost to consumers, representing a decrease of nearly 25 per cent in rates. The compromise resulted in dismissal at the utility's cost of a federal court litigation which was to get under way in a few weeks. The new rate is a reduction to 5.5 cents for the first 100 kw.-hr. against 7 cents with 3 cents a kilowatt-hour for all additional power in residential districts. The new schedule is effective as of January 1 and where January bills have been paid allowances will be made. Under the agreement the utility consented to reduce valuation of its properties from approximately $15,000,000 to $10,000,000.

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800,000-Volt X-Ray Tube

Roentgenologists at the Mercy Hospital in Chicago will be able to treat cancer patients with the electrical equivalent of 1½ kg. of radium (value $75,000,000) when the equipment just produced by the General Electric research laboratories in Schenectady is installed. Advantage of the high-power tube is said to lie largely in the reduced discomfort to the patient when rapid treatments are given.

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Purchase Price Not a Rate Base

In approving the purchase price and acquisition of the Consolidated Public Utilities Corporation of Westminster, Md., by the Consolidated Gas, Electric Light & Power Company of Baltimore, the Maryland Public Service Commission has specifically stated in a second order that the figure at which the deal was effected would not be acceptable for rate-making purposes.

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Another Williams Investment Trust

Incorporated in Maryland, a new open-end investment trust with a capitalization of 20,000,000 shares of stock, all of one classification, has been founded under the name of Utilities, Inc., as another member of the Harrison Williams group. Others, some in existence for some years, are the Shenandoah, Blue Ridge, Central States Electric, Cities Power & Light and Electric Shareholders corporations.

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Tennessee Rates Reduced

Reduction in electric rates averaging 15 to 20 per cent in territory served by the Tennessee Public Service Company has been ordered by the State Railroad and Public Utilities Commission. The new rate will mean a reduction of $75,000 to $80,000 a year in earnings of the company.

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Scottsbluff Council Acts

Latest in the many developments at Scottsbluff, Neb. (ELECTRICAL WORLD, January 28, page 120), is the issuance of an order by the City Council for the Western Public Service Company to reduce its rates for electricity from 10 to 18 per cent. Consumers have been told to pay their bills at the reduced rates regardless of how the company may bill them.

Rock Island on the Line

Less than three years after construction work started, the completed Rock Island project was formally turned over to the Puget Sound Power & Light Company on February 1 by the Stone & Webster Corporation. The power company is now in complete charge of operations and three of the four 20,000-hp. generators are now developing power. The fourth will be in operation shortly. Twelve units are planned for the completed station.

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Farm Energy Federal Tax Ruling

Holding that general farm use of energy or that of a dairy which obtains milk and converts it into use for retail purposes is domestic or commercial in character and the energy used subject to tax, while that used in dairies which are engaged in the manufacture and sale of butter, cheese and similar dairy products is industrial and not subject to tax, the Bureau of Internal Revenue has endeavored to clarify another point of misunderstanding in the revenue act of 1932.

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Crisp County Gets Industrial

Georgia's experiment in county-ownership of electric light and power service, the much-discussed Crisp County power plant, has secured a large industrial customer. The Glover Machine Works has moved from Marietta to Cordele, Ga., and its $30,000 annual use of electricity for furnace purposes will aid the Crisp County experiment, sometimes reported languishing.

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British Electrical Stocks Boom

While all classes of corporate securities have slumped in mutual despond in this country, Great Britain has a different story to tell. Stocks of the companies supplying electric light and power in the British Isles have moved to new record high prices, in many cases nearly those of 1929. Yields on the better-known issues approximate 4 per cent. Electrical output there is touching all-time highs too (ELECTRICAL WORLD, February 4, page 150).

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New Arkansas Commission Formed

To supersede the State Railroad Commission, Tax Commission (had jurisdiction over electric light and power companies) and Department of Conservation and Inspection, which have been abolished, the Arkansas Corporation Commission has been created by the State Legislature. The new commission consists of W. H. Childers, J. C. Pinnix and C. P. Newton. Mr. Childers was a member of the Tax Commission.

Want Continuous Rating on High-Voltage Fuses

Considerable demand has developed among utilities for a nameplate rating on high-tension fuses to show their continuous current-carrying capacity directly without computation. According to a report recently submitted before a group of engineers and based on the replies of about 23 operating companies, five management or holding companies and one large industrial, engineers cannot determine this rating from the N.E.M.A. rating (rules SG 8-71 and SG 9-11) without applying a factor of 65 per cent. Furthermore, since the N.E.M.A. rating also has to be multiplied by other factors depending on ambient temperature and time-current relations to obtain rupturing rating, the report contends the present rating has no direct significance for either continuous or rupturing rating.

Quoting from the report: "The difficulties involved in a return to a logical basis of rating should not be very serious. It would not be necessary to make any physical change in the equipment now being manufactured other than to change the nameplate rating to 65 per cent of the nameplate rating under the present N.E.M.A. rules; that is, a "100-amp. fuse" which will carry only 65 amp. and will blow at 150 amp. would become a "65-amp. fuse," but it would still carry 65 amp. and blow at 150 amp.

"The reason for bringing up this matter at the present time is the fact that there is no American standard for fuses. The A.I.E.E. committee on protective devices has a proposed standard ready for consideration by the A.I.E.E. standards committee and the American Standards Association. If an American standard is to be adopted, it certainly should include a logical rating on a fundamental basis in line with the rating of all other electrical equipment and not an arbitrary, intermediate rating which is neither one thing nor the other."

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High-Speed Protection Aids Defeat of Lightning

One opening per year per 100 miles of circuit due to lightning disturbance has been experienced on the 220-kv. double-circuit line of the New England Power Association system between the Fifteen-Mile Falls (Comerford station) and Tewksbury since service began in October, 1930. E. W. Dillard, electrical engineer of the association, told the Boston section of the A.I.E.E. last week that a total of five operations was caused by lightning. The total length of the line is 126 miles. The two circuits are sectionalized at a mid-point into quadrants and there are no taps between terminals (ELECTRICAL WORLD, September 6, 1930, page 443).

In each of these "shots" only one section of one circuit went out of service, there was no interruption of power flow over the line, no load was dropped and the open section was immediately restored to duty. The flashovers produced no sign of damage. High-speed relays and high-speed circuit breakers functioned perfectly. Commenting on the performance of this line, which supplies firm power on a 2,000-hour-per-year basis to the Boston Edison Company, F. W. Peek, Jr., chief engineer Pittsfield Works, General Electric Company, said that when the design of the line was completed four years ago he could suggest no improvement from the standpoint of lightning protection and that the service record justifies the same characterization today.

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Miami Would Lower Utility Rates

Reduction of 29 per cent in electric rates for Miami, Fla., has been voted by the City Commission, which also adopted a resolution asserting that the Florida Power & Light Company's rate base should be $9,200,000 instead of $21,000,000 now used; that its net earnings should be 7 per cent instead of 10 per cent, and that rates should be established accordingly.

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Utility Sues for $264,571 Bill

Unable to collect from the city of Long Beach, N. Y., a $264,571 bill, two years in the accumulating, for light and power service furnished that community, the Queensborough Gas & Electric Company has entered suit. Long Beach City Council has refused to enter a new five-year contract at the present rates and the company presented its bill for immediate payment as the alternative.

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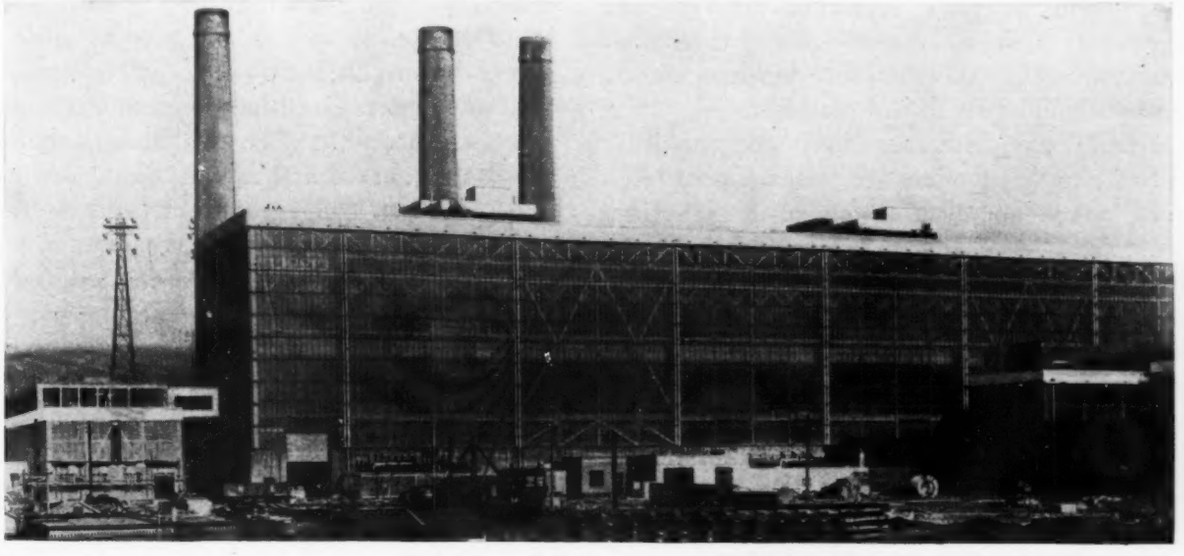
Dunstan Station Has Walls of Glass



Rare, if not unheard of, in the annals of power generation is the new 150,000-kw., £3,000,000 Dunstan station of the North-Eastern Electric Supply Company, Newcastle-Upon-Tyne, England, with its glass walls.

This latest addition to the British national grid scheme is not only said to be the largest in the British Isles but it is "daylighted" quite thoroughly. Walls of glass in which masonry is virtually non-existent distinguish Dunstan from its contemporaries. Three 50,000-kw. turbo-generators are now in operation. As the control center for the North-Eastern system an elaborate board has been installed at Carliol House, 4½ miles from the station.

EDITORIALS

L. W. W. MORROW
Editor

Young suggests simplification

FAVORABLE comment was had on the suggestion of Owen D. Young that single holding companies over groups of operating properties were preferable to the present pyramid structures. This conception has long been held by utility executives, but many legal and financial difficulties have been encountered in attempts to do this. The holding company was conceived as a corporate entity to consolidate and integrate individual enterprises and thus permit of more rapid, more economical and more logical territorial development of the utility business. It was not formed for financial reasons, except in a few instances. It was the only practical mechanism for consolidation and development and the chief financial incentives were to secure diversity in holdings so as to stabilize earnings and to secure uniformity in policy so that more business could be sold by the most successful methods.

Experience has indicated that geographical limits for a utility under one management are not very large—not even statewide in many instances. Experience now indicates that holding companies also are subject to definite economic limits and these are primarily based upon the capital structures that can be sustained by the common-stock dividends of operating properties in times of depression. Economic forces as well as better-conceived policies are rapidly forcing the elimination of the pyramid holding companies despite the very tangible legal and financial difficulties encountered in individual instances. The policy stated by Mr. Young is sound and a great amount of holding company simplification is to be expected in future.

Loyalty and enthusiasm

ELECTRICAL men and women have no reason to lose their enthusiasm and loyalty for their industry. The past records are splendid and the future holds even greater promise. Yet there is current in many quarters an inertia, an apathy and a fear. Too many assume even an apologetic attitude for belonging in the industry. The incessant attacks of agitators, the drop in business, the crash of security prices, the internal changes of organization and associations, the unemployment and the drastic economy orders of holding companies and manufacturers—all these have disturbed the morale of the rank and file and developed an attitude of defense even among the leaders.

Times are bad and they may be worse, but this is no reason to quit work, become disloyal or admit defeat. It is a time to go to work and to become tempered and hardened by a success that will be earned only after a battle. Facts must be faced and much that has been built must be torn down, but two things stand out. All the tangible assets of the electrical industry remain. It has products and services that are needed and it has a fertile engineering and research group to develop more assets. In the second place the road to prosperity lies in hard work in each community and not in political or economic palliatives. There is nothing stronger in the nation than the electrical industry, there is nothing that can do more to produce better times and there is no limit to the present opportunities for work and progress. But the essential to accomplishing these goals is a hard-working, enthusiastic and loyal industry personnel from the top to the bot-

tom. A changed industry attitude is the first essential for success, and it is high time to go to work and forget fears. We should be proud of our industry, loyal to its purposes and incessantly busy in accomplishing these purposes.

Utilities could administer traffic signal systems

TRAFFIC signal installations represent more energy consumption per intersection than the prevailing street lighting for the same intersection. Such signals cost Chicago $67.33 each for the 1,761 in service in 1931. Of this cost $24.44 was for energy and the balance for maintenance and supervision overhead without other fixed charge overheads. The street lighting, including these latter fixed charges, ranged from $39.89 for 100-cp. lamps to $104.88 for 1,000-cp. lamps off underground mains.

Traffic lights burn more hours per day than street lights. They also impress themselves more on the consciousness of the traveling public than do the street lights. There is better chance in their application to win public favor by intelligent location, intelligent operation and intelligent maintenance. There are many cities where the whole traffic light system could well be financed, installed, operated and maintained by the electric utility.

There should be nothing startling in such a suggestion. Street lighting is beginning to be viewed as a definite adjunct of travel safety. Traffic signal lights are for the same purpose. The two are kin and could appropriately be sponsored and administered by the same agency. There is no more reason why municipalities and villages should set up technical staffs to operate their traffic lights on purchased energy than that they should do so with their street lights. Utilities could well give traffic signals a deserving boost by taking them under their wing and operating them to the better satisfaction of the drivers who grumble at the red and exhilarate on the green.

Highway lighting for vision and for caution are destined to go hand in hand. If the utilities wish to hold one they should take over the other, to their own advantage and that of the public, both as taxpayers, motorists and pedestrians.

Combating the high cost of cord failures

SOMEWHERE around 40 to 50 per cent of the service calls made by power companies for domestic customers are caused by cord failures on household appliances. A service call costs the company from $1.50 to $3. Multiplied by the number of these calls made daily throughout the country, this runs into a very large sum of money in the course of a year. But this is but a part of the loss it represents. For not every appliance that gets out of order because of cord trouble is reported. Many of them are set back in a corner of the closet, out of use. And an abandoned toaster, percolator or cleaner meters no kilowatt-hours. Cord failures, therefore, take a heavy toll, both in terms of loss of service to the householder and of income to the industry.

Because of all this, the so-called "identified cord" movement which has been organized by a group of 29 wire manufacturers has a broad interest to the entire electrical industry. It strikes at a vital weakness in electric service to the home today and it is instituting steps toward the correction of the present unsatisfactory situation, first by conspicuously identifying all approved cords in the process of manufacture and then by arousing the inspectors of the country to the importance of consistent local effort to prevent the use of unsafe cords.

In a few cities there are ordinances prohibiting the sale of substandard appliances and hazardous cords. But such ordinances must be policed. In all communities results depend upon the co-operation of the merchants who sell appliances and upon public education. So the cord manufacturers are enlisting the co-operation of the inspectors. The inspectors are appealing to the dealers to refuse to buy appliances for resale wired with unsafe cords. In Chicago 13,000 have agreed. Kansas City, Minneapolis, Washington, Philadelphia, New York and Boston are being canvassed. The present program will embrace 106 cities, covering a population of 40,000,000 people. Inspectors, utilities and leagues are helping.

These manufacturers are doing a job here that deserves the support of every electrical man. For every appliance that breaks down hurts the electrical business. And a large proportion of these breakdowns are now avoidable.

Heating Metals and Alloys Inductively Has Advantages

By E. F. NORTHRUP*
Vice-President Ajax Electrothermic Corporation, Trenton, N.J.

AT SOME stage in their fabrication practically all metals and alloys not directly cast into their final molds require a reheating to some point below their melting temperature for the purpose of annealing, normalizing or forging. Inductive electric heating can meet the requirements of many of these processes as it has done in the field of melting. For extremely fast heating the inductive process is unexcelled because it generates the heat within the mass instead of imparting it from without by absorption and conduction. The general character of material to which inductive heating may be best employed may be summarized thus:

(a) The metal pieces to be heated best should have a certain symmetry of form.
(b) Large diameters are favorable to the inductive method.
(c) Magnetic metal is cheaper to heat than non-magnetic.
(d) The ratio in economies of inductive to fuel heating increases with increase in the final temperature demanded.
(e) For extremely fast heating the inductive method is unexcelled.
(f) Localized heating of a part of a large metal piece is most readily accomplished by induction (arc heating excluded).

If proper use be made of any or all of the following induction methods it is possible to show that all non-ferrous non-magnetic and many magnetic ferrous metals having any of the forms listed above may be heated to a temperature as high as commercial requirements impose and with better control of temperature, more uniformity in temperature and with higher economy than can be obtained by the methods now in extensive use in which fuel or electricity is employed.

(a) Those methods in which the heating is wholly by direct induction, by which we mean that the alternating current in an inductor develops an alternating magnetic field which acts directly on the susceptor, heating it and nothing else.

Abstract of paper presented at recent meeting of Pittsburgh Section, Association of Iron and Steel Electrical Engineers.

(b) Those methods in which the materials to be heated are placed in a muffle, the muffle walls only being heated by induction.
(c) Combination methods in which part of the heating of the susceptor is by direct induction and the remainder by heat radiated to it from the walls of a specially contrived inductively heated muffle.

The effectiveness of inductive heating depends upon the "coupling coefficient," which in turn depends on the ratio of the area of the susceptor (mass to be heated) to the cross-axial area within the inductor (the coil which acts as the primary of the high-frequency transformer). Coupling less than 50 per cent reduces the efficiency rapidly below 80 per cent. For this reason symmetrical sections are best adapted to induction heating.

Non-ferrous non-magnetic metals and alloys which require to be heated for annealing or other purposes may be classified in respect to shape as·

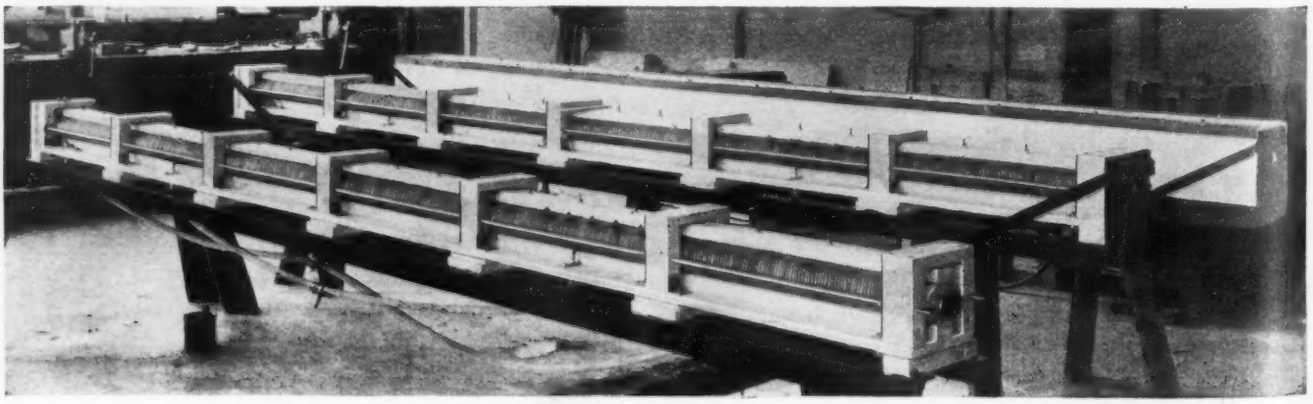
1. Solid round billets.
2. Solid square or rectangular billets.
3. Rods, round or square, in diameter 1 in. or under.
4. Drawn wire of all sizes up to about ¼ in. or under.
5. Sheet metal in strip which is to be heated by continuous travel through the heating device.
6. Sheet metal, usually of large area, which must be heated in batches by a discontinuous process.
7. Round tubes of all sizes and lengths and wall thicknesses and tubes of square, rectangular, oval or other cross-section.
8. Masses of metal of various sizes and irregular shapes.

Direct induction can give high speed of heating

When use of the direct inductive method is contemplated the availability of reasonably priced frequency-changing equipment first deserves attention. The tonnage to be handled in the heating of billets and tubes must be sufficient to justify the installation of a motor-driven generator to supply current at a frequency of not less than 500 to 1,000 cycles per second and in special cases as high as 5,000 cycles. The second consideration is

High-frequency heaters for razor blade steel

Six such muffle heaters are served by a 60-kw., 550-volt, 4,800-cycle, three-phase G.E. generator. The heaters are 14½ ft. long. Muffle is 0.1 in. wall nichrome in the form of a 2-in. tube flattened to oval.



Short inductor heats chromium-plated tubes

The Heppenstall Company of Pittsburgh devised a scheme for heating tubes at 960 cycles. The inductor is short; it is seen between the hold-down straps. Tubes are rotated and advanced by revolving asbestos board disks which feed the cold tube into the inductor and again take the white-hot tube as it emerges from the heater. Power is taken from the 150-kw. generator which is used primarily for melting high-grade steels.

technical, in that the resistivity and the least dimension of a transverse section of a solid susceptor, as a billet, be such that the greater portion of the electromagnetic energy which flows into it becomes changed into heat. Finally the susceptor must have a geometrical symmetry.

No other known method can compare with the direct induction method for rapidly heating any considerable mass of conducting matter. Any heat which enters a mass placed in a hot chamber must enter that mass chiefly in the form of radiant heat through its surface. The radiant heat energy is a radiation produced by a frequency of the order of 6×10^{13} cycles per second. Hence when this radiant heat energy falls upon the surface of a metal from which it is but little reflected, it is all converted into heat energy in the time it has penetrated below the surface only by 5×10^{-5} millimeters or less. The heat so produced can go further into the mass by the process of heat conduction only, which is exceedingly slow in masses of moderately low thermal conductivity.

On the contrary, when direct induction methods are used and a moderate frequency of, say, 1,000 cycles per second is employed the conversion of the electromagnetic energy into heat in this case takes place, in large part, well below the surface, a centimeter or two, and, by proper choice of frequency, as far below as may be desired. Consequently, with a sufficiently large source of high-frequency power available, and with a correctly designed and water-cooled inductor, the speed of heating, even a large mass, is in principle without limit.

In one particular case a 1-in. diameter steel rod 4 in. long was made to absorb 60 kw. and it came from room temperature to a forging temperature in two or three seconds. With still more power at one's disposal this rod might have been heated as if struck by a hammer of electrical energy.

Batch and continuous heating by muffles

The most simple and often most useful form of an inductively heated muffle is one in which a tubular muffle furnace is maintained at a desired temperature by heating the tube inductively with an inductor coil which surrounds it. The tube may have any desired length and be of any cross-section as round, oval, square, rectangular or semi-circular with a flat bottom. The material of the tube may be nickel-chrome, chrome-steel or even graphite when provision is made to protect this from oxidation.

Whatever the material or form of the tube, it should be considered the susceptor on which the inductor acts.

The inductor winding is usually made to conform to the contour of the cross-sectional area of the susceptor. It is good practice to make the coupling between inductor and susceptor between 50 and 60 per cent. The space between the two is filled with any suitable highly heat-insulating refractory.

The material to be heated as strip metal, rods or tubes may be intermittently placed in the muffle until it has reached the desired temperature or the same may be fed steadily through the muffle. All heating of the material results from heat radiated to it from the inside wall of the muffle. It is easy to maintain the heating chamber filled with a protecting gas.

The wall thickness of a tubular muffle would be chosen usually from $\frac{1}{8}$ to $\frac{1}{4}$ in., but it may be much thicker, if desired, without appreciably altering the efficiency of the muffle heater.

A muffle heater of this character, with heavy duty to perform, should be generally not less than about 2 in. in its least outside diameter. The reason for this is that a higher frequency is required inductively to heat efficiently a susceptor which has a small diameter than one of larger diameter. The highest frequency which may be economically supplied with a generator is about 5,000 cycles and an inductor type of machine is required for this.

It takes about 5,000 cycles to heat a susceptor as small as 2 in. in diameter efficiently. Wire-wound alternators are now standardized to give 960 or 1,000 cycles. This frequency is quite adequate to heat a 4-in. diameter susceptor, but hardly high enough for one only 2 in. in diameter.

Razor blade steel cheaply heated

A manufacturer of razor blades has in service six inductively heated muffle furnaces (see accompanying illustration) which are giving entire satisfaction both from the technical and economic viewpoints.

The heaters operate at a temperature of 812 deg. C. (1,500 deg. F.) and it is essential that a uniform temperature be maintained throughout the length of the muffle with the exception of 1 ft. from the exit end. The number of turns per inch are increased at this point to bring the temperature up to 870 deg. C. (1,600 deg. F.).

The heaters are electrically connected so that a balanced

three-phase load is had when all the furnaces are on. In order to provide a balanced load when one or more furnaces call for a drop in temperature (power off) a dummy load is used. This load consists of a water-cooled resistor and draws about the same amount of power as one heater. There is one dummy load for each heater.

A temperature controller is connected to each heater and these are so arranged as to provide three controls, namely (1) off (no power), (2) holding power (constant temperature) and (3) raising power (rise in temperature). These controls operate contactors mounted on the switchboard in the generator room and function according to the temperature demands of the muffle.

It was found by test that the following power requirements were best for one size of strip steel:

"Holding" power—6.8 kw.
"Raising" power—8.8 kw.
Off (dummy load)—7.5 kw.

With the power taps adjusted as above, it requires but 40 minutes to bring the muffle up to temperature from the cold.

The thickness of heat insulation on the muffle was so designed as to give a reasonable efficiency and at the same time permit the temperature of the muffle to drop quickly. This feature is highly desirable as it gives a precision control of the temperature. For example, after the working temperature has been reached it is possible to raise the temperature 25 deg. F. in one minute with the "raising" contactor and also cause a drop of 40 deg. F. per minute on the "off" position. In the general operation of these muffle heaters a temperature is held throughout the day at 1,600 deg. F. with a variation of less than 0.4 per cent of absolute.

Economies—The six heaters operate continuously with a power input of 62 kw. measured at the motor terminals.

The total production of heat-treated strip steel for the six heaters amounts to 92 lb. per hour, giving a power cost of 5 mills per pound at 7.5 mills per kilowatt-hour or $5 per 1,000 lb.

The fuel cost of heating 92 lb. of steel per hour in the former gas-fired furnaces was found to be at the rate of $22 per 1,000 lb. This amount corresponds to 39 per cent of total capacity of the gas furnaces as actually checked for a four-month period. A saving of more than $3,000 for this period, or $9,000 per year, is indicated.

It is necessary to keep the gas on even if the furnaces are not in production, due to the great length of time required to bring the muffles up to working temperature. This usually requires from three to four days, while the electric muffles require only 40 minutes to attain the proper temperature.

Multiple chambers adapted to batch jobs

For batch heating in inductively heated muffles use may be made of the advantages of multiple chambers. Hollow rectangular castings are stacked in three or more columns to the desired height or length. They contain the work and are heated inductively (through intervening refractory or other heat insulation) by means of the high-frequency supply to the external water-cooled inductor. This scheme, using chrome steel shells, is workable up to 1,300 deg. C.

Sheet and strip metal in continuous travel is very difficult to heat by direct induction and the best results are obtained by inductively heated muffles, exposing their heated flat surfaces to the sheets and strips. Semi-induction is also feasible under some circumstances. Laboratory tests on unit sheets and on 5x¼-in. strips show the radiation-induction sheet heater to be wholly feasible.

In the case of billets of magnetic steel it is found that the kilowatt-minutes per pound to bring the material up to 600 deg. is just about equal to the number required to bring it to the forging temperature of 1,200 deg. C. The first stage can be accomplished effectively and practically by 60-cycle induction. The second stage is best accomplished at 1,000 cycles, especially for billets of 3 in. or larger diameter. The paper also discussed induction heating methods for batch sheets, fluids or gases (passed through re-entrantly fluted pipes inductively heated), pipes that are to be given local bends or flanged, etc.

▼

Desirable Characteristics in Lead Cable Sheaths

Lead grades II and III, characterized in the accompanying tables, are best adapted to cable sheaths, according to W. H. Bassett, Jr., technical superintendent and metallurgist Anaconda Wire & Cable Company. In a recent paper before the N.E.L.A. underground committee he presented numerous photo-micrographs showing cable sheath flaws produced by improper or careless foundry practice or factory control. In conclusion he remarked that radial or longitudinal welds can always be relied upon under proper factory control; that laminations, blisters and serious oxide inclusions can be avoided by good foundry practice; that flow lines and small suboxide areas do not impair tensile strength, elongation and bursting strength of cable sheath, and that lead crystals cannot absorb or grow across well-defined oxide areas.

Referring to Mr. Zickrick's paper,* he pointed out

Effect of Constituents in Cable Sheaths

	Grade I Corroding per Cent	Grade II Chemical per Cent	Grade III (a) Desilverized per Cent	Grade III (a) Soft Missouri per Cent
Lead (by difference)	99.9330	99.878	99.7265	99.931
Silver — not over	0.0015*	0.015	0.002	0.002
Copper — not over	0.0015*	0.08	0.0025	0.04
Arsenic, antimony and tin — together not over	0.0110†	0.015	0.015	0.015
Bismuth — not over	0.05	0.005	0.25	0.005
Iron—not over	0.002	0.005	0.002	0.005
Zinc—not over	0.0015	0.002	0.002	0.002

*Copper and silver together not over 0.0025. †Arsenic not over 0.0015.

Kinds of Lead Sheath	Tensile Strength per Sq.In., Lb.	Elongation in 2 In., per Cent	Bursting Pressure per Sq.In., Lb.
Grade II	2,145	43.4	220
Grade III (a)	1,950	53.2	208
Sample containing oxide area at flow line	1,971	35.7	210
Sample containing oxide streak	2,222	34.0	227
Same sample annealed for two hours at 260 deg. C.	2,343	37.0	239

that a high purity lead when subjected to pressures under conditions such as found in the lead press flows much more readily than lead containing alloying metals. It also indicates the effect of alloying with small amounts of various metals; thus, bismuth (0.090 per cent) slightly retards the flow of the lead. A small percentage of copper (0.07 per cent) has a very pronounced effect on the flow of the lead. This paper, as well as field observations of lead water pipe and cable sheath, shows that grades II or III are the most satisfactory for cable lead sheath, according to Mr. Bassett.

In other words, very high purity lead corrodes more rapidly and is so soft that it does not have the strength or hardness which the electrical industry expects to find in its cable lead sheaths.

*A.I.M.E. Institute of Metals Transaction 1932. Vol. 99, page 345.

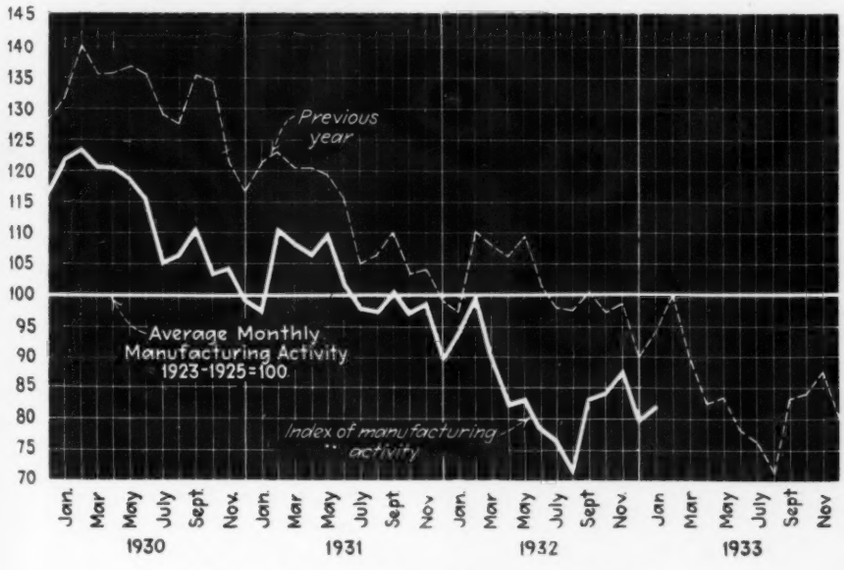
January Advance Modest but General

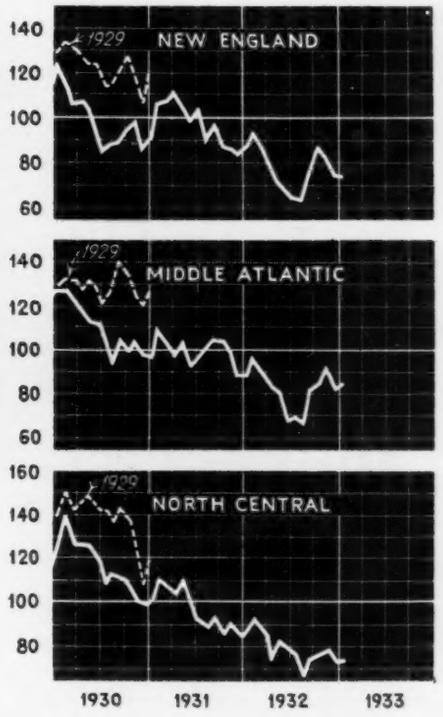
Industrial activity in January, measured by electrical energy consumption, averaged slightly higher than in December, the gain being somewhat smaller than a year ago, but contrasting favorably with a decline two years ago. The present level is 13 per cent under that of January, 1932. While the rise from December did not exceed 3 per cent, as to the general average for all industry, the forward movement occurred almost all along the line.

Without ignoring the fact that the current winter's industrial operations as revealed by these figures are at a far lower ebb than in any other recent year, there are certain favorable indications that also should not be ignored in an appraisal of conditions and trends. It is highly probable that the downward movement that set in early in 1929 and continued more or less steadily for 3½ years struck its low point in August. This is evident from the chart. Since that month there has been a definite rise. The January index exceeds that August minimum by 11 per cent. To find a similar rise we must go back to the period prior to 1929.

Further, it will be observed that January activity approached that of September, the first recovery month, missing it by no more than 3 per cent. In none of the three past years has the approach been anything like so close.

Most striking of recent changes has been the persistent climb of the automobile group of industries. It has gained 75 per cent compared with August, 62 per cent over September and 57 per cent over October, and seems to be on the way gradually to make up the 30 per cent difference from last year's rate of operations. Meanwhile the metal industries have revealed no pronounced tendency to move one way or the other during the past three months, but here again the longer view discloses a rising trend if late summer is taken as the starting point. In the stone, clay and glass group the usual mid-winter recession is evident. Building and construction seem to be less active even than a year ago, the index being down 23 per cent. The changes observed in the country as a whole are in evidence also, in the main, in the several geographical regions.


Previous year
Average Monthly Manufacturing Activity 1923-1925=100
Index of manufacturing activity
Jan. Mar May July Sept Nov. Jan. Mar May July Sept Nov Jan. Mar May July Sept Nov Jan Mar May July Sept Nov
1930
1931
1932
1933



Index of monthly manufacturing activity

Base: Average month 1923-1925 = 100

(Corrected for number of working days, but not for seasonal variation)

These data are compiled by ELECTRICAL WORLD and are based on monthly consumption of electrical energy by 3,800 large manufacturing plants in various industries and scattered throughout the country.

Industrial Group	United States				New England				Middle Atlantic				North Central			
	Jan., 1933	Dec., 1932	Nov., 1932	Jan., 1932	Jan., 1933	Dec., 1932	Nov., 1932	Jan., 1932	Jan., 1933	Dec., 1932	Nov., 1932	Jan., 1932	Jan., 1933	Dec., 1932	Nov., 1932	Jan., 1932
All Industry	**81.9**	**79.4***	**87.7**	**93.9**	**74.4**	**75.2***	**84.0**	**85.8**	**84.8**	**83.3***	**91.3**	**89.6**	**74.1**	**72.1***	**78.5**	**89.5**
Automobile (including parts and accessories)	59.2	56.2*	47.3	83.6	.....	.....	.....	.....	65.5	67.0	62.6	91.7	58.7	55.6*	46.5	84.1
Chemical products (including oil refining	126.0	124.3	130.1	134.3	132.6	134.0*	140.5	149.7	131.7	128.0	136.2	145.6	116.0	112.7*	118.7	117.3
Food products	108.7	103.2*	121.3	127.2	.....	.....	.....	.....	111.3	104.4	130.0	95.8	104.7	97.3*	115.5	110.8
Iron and steel	57.7	54.0	57.5	77.6	68.3	80.8	98.0	94.0	45.7	45.6*	46.8	73.0	65.5	58.5	61.3	76.2
Metal working	53.1	52.7*	56.1	72.7	70.9	71.4	81.2	91.3	50.6	52.2	53.3	75.5	51.2	49.0*	53.0	68.7
Metals group	54.7	53.3*	56.6	74.2	70.2	74.3	85.9	92.1	48.5	49.3*	50.7	74.4	56.5	53.0*	56.3	71.6
Leather products	82.8	79.8*	95.4	81.4	74.8	62.0*	80.7	72.8	95.8	101.0	120.3	88.7	77.1	79.0	84.8	69.5
Forest products	90.4	83.5*	96.2	81.9	36.3	36.3*	43.2	43.2	51.7	54.0*	56.2	57.2	69.6	67.3*	84.3	89.6
Paper and pulp	102.1	98.8*	113.6	109.3	99.2	101.0	107.5	122.7	74.8	60.0*	66.7	68.4	103.0	93.3*	115.8	100.8*
Rubber products	85.2	77.2	93.0	104.0	91.2	97.8	103.8	95.1	.....	.....	.....	.....	81.5	70.5	87.6	113.4
Shipbuilding	83.5	84.0	84.0	93.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stone, clay and glass	59.3	56.2*	81.9	77.1	.....	.....	.....	.....	45.2	36.2	61.7	51.7	68.7	66.5*	99.7	106.7
Textiles	85.0	86.5	93.0	87.8	63.7	63.5	68.3	65.6	111.8	117.8*	124.0	102.0	103.8	109.0*	124.5	109.2

* Revision.

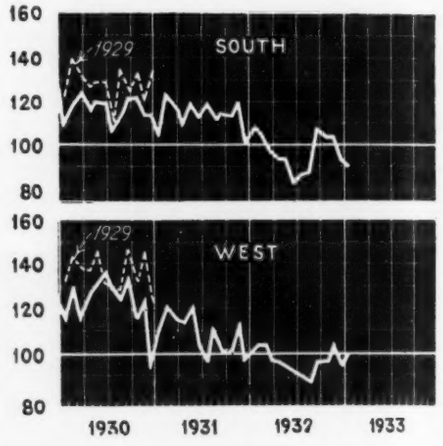
South Loses, West Gains

In the South several factors combined to lower the average index of industrial activity 4 per cent in January compared with December. The recovery of iron and steel, after a sag in December, and some other more moderate gains did not compensate for the 7 per cent decrease in textiles and the abrupt change in the stone, clay and glass industry. Individual returns in this group reveal a remarkable diversity, due presumably to the sporadic nature of present-day construction work. Consequently quarrying, the digging of sand and gravel and the manufacture of cement may be active in one locality, and quite dormant in another close by, whereas ordinarily individual returns conform fairly well to the general movement. Two of the industrial groups listed in the table are more active than they were a year ago, namely, textiles and paper manufacture, while chemicals are down but slightly.

In the West a considerable gain after the sag in December brought about a return virtually to the November level, which was the highest since the early part of 1932. Here, as in the United States as a whole, the fact of an advance along nearly the entire industrial front catches the eye, rather than its magnitude. Forest products, paper and pulp, and shipbuilding are more active than a year ago. The metals group, though still far below former levels, is at any rate not making any new low records but is running along approximately as in early 1932. Figures for stone, clay and glass, including the manufacture of cement, were materially greater than in December for the larger reporting companies, though some of the smaller ones reported a decrease.

Industrial Groups	South					West				
	Jan., 1933	Dec., 1932	Nov., 1932	Oct., 1932	Jan., 1932	Jan., 1933	Dec., 1932	Nov., 1932	Oct., 1932	Jan., 1932
All Industry	**90.1**	**94.1***	**104.4**	**103.8**	**106.0**	**100.0**	**93.8***	**101.3**	**96.8**	**104.0**
Chemicals	132.7	142.6*	142.9	146.8	136.2	78.2	76.8	82.2	86.0	92.0
Food	129.0	124.3	138.7	151.0	154.9	116.2	113.2	113.0	112.0	129.0
Iron and steel	81.7	57.6	71.7	85.7	145.2	.....	.....	.....	.....	.....
Metal working	55.3	54.5	61.7	64.3	64.1	.....	.....	.....	.....	.....
Metals group	70.0	56.3	67.2	76.2	109.5	44.6	37.5*	43.1	42.8	45.3
Forest products	36.6	38.7	51.4	50.5	59.8	145.7	130.3*	145.7	132.8	136.0
Paper and pulp	137.7	138.4*	157.5	145.0	124.8	138.4	125.5	141.7	139.5	121.0
Rubber products	57.3	30.6	78.8	78.6	96.7	76.2	50.2	62.5	75.8	103.7
Shipbuilding	.....	.....	.....	.....	.....	107.3	112.4	113.0	88.5	96.7
Stone, clay and glass	73.0	117.3*	143.4	113.8	106.7	78.0	64.5*	77.7	71.3	83.5
Textiles	101.5	108.8*	117.0	107.8	97.4	.....	.....	.....	.....	.....

* Revision.



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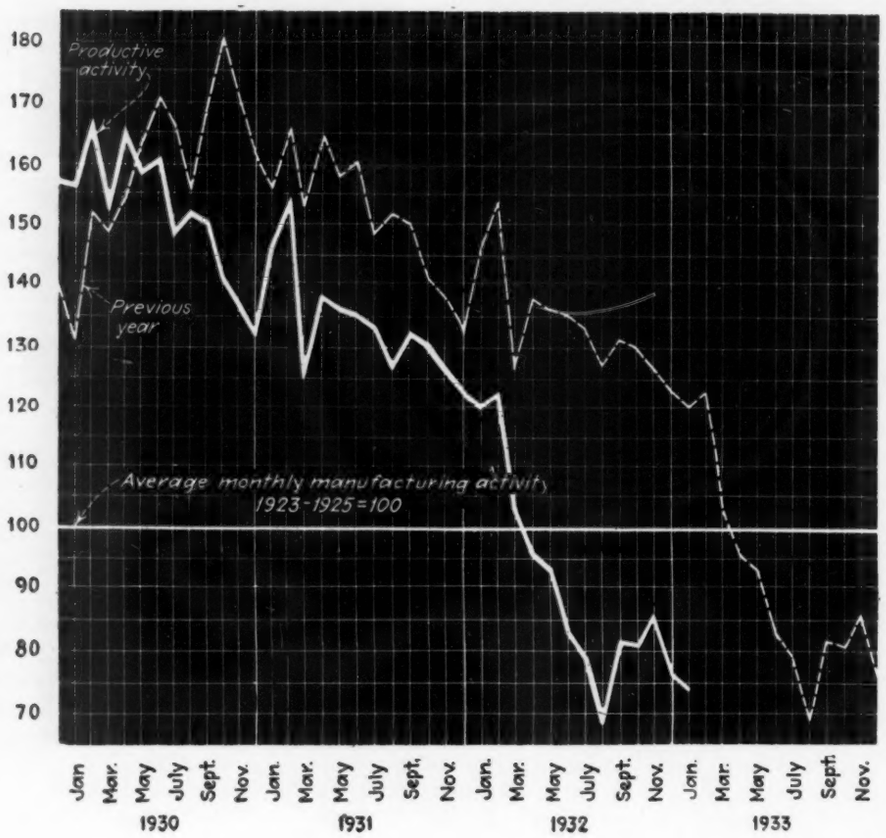
Electrical Manufacturing Slow



Electrical manufacturing plants continue operating at a low rate, it appears from reports of electrical energy consumption in this branch of industry received by ELECTRICAL WORLD. January activity averaged 2.7 per cent under December, but there remains a 10 per cent gain compared with August, the low month.

In the Middle West comparable returns fell nearly 12 per cent, although January had only one less working day than December. Appliance manufacturing plants generally decreased operations, yet such exceptions are to be noted as one concern's 35 per cent increase. In the eastern part of the country the previous level was nearly maintained, though New England shows a downward tendency

Monthly Index of Electrical Manufacturing Activity

Adjusted to 26 working days

Base: Average Month, 1923-1925

Month	1930	1931	1932	1933
January	156.2	146.6	120.0	74.0
February	165.2	154.3	122.2	.....
March	153.0	126.1	102.9	.....
April	164.9	138.1	95.6	.....
May	158.0	136.7	92.8	.....
June	160.2	135.2	83.1	.....
July	148.5	133.4	79.2	.....
August	152.2	126.9	67.6	.....
September	150.0	132.6	81.4	.....
October	140.6	130.4	80.9	.....
November	137.5	126.9	85.6	.....
December	132.4	123.5	76.0	.....

Power System Insulation Co-ordination

By A. E. SILVER
Consulting Electrical Engineer
Electric Bond & Share Company

Suggests segregating surges as to source and characteristics and analyzing separately for cause and effect.

Six elements considered essential to approaching solution of problem.

POWER system insulation co-ordination is a basic problem, and because it correlates all elements of the power system, including the relation of manufacturer and user, it cannot be solved by interested groups acting separately. Past efforts and experience have shown this. Knowing that a N.E.L.A.-N.E.M.A. joint committee on insulation co-ordination is now working on the development of a sound, co-ordinated solution of this problem, it is furthest from my desire to suggest or encourage a reversion to the treatment by individual groups. Hence it is with reluctance that I express my requested views on the problem:

Existing insulation practices for all parts of the system, of necessity, have grown largely through the cut-and-try method of coping with the potentials encountered, regardless of their characteristics or source. Potentials of atmospheric origin have been bunched with those of system internal origin; i.e., lightning surges, switching surges and the like have been lumped. The trend in insulation levels has been steadily though slowly upward, but without success in effectively topping these surge voltages. Insulation spillovers and failures still persist.

Results of the comprehensive natural lightning research of the past several years have thrown much light on the nature of the lightning surge voltages encountered. System surges now can be segregated with understanding in two distinct types, dissimilar both as to characteristics and source. These are:

1. Surges attuned to fundamental frequency, originating within the system, of maximum values within practical insulation range.

2. Lightning surges of impulse character which initiate only on the overhead lines and which reach values beyond the range of economical or practical insulation. It is reasonably believed that the modern station can be made essentially immune to lightning strokes contacting the conductors within the station.

Separate analysis of the causes and effects under these two classifications affords an approach to the problem of system insulation co-ordination for improving both service and economy. Service and economy must be the gage of any measures for adoption. Accumulated experience largely must provide the basis on which to build the solution, but using the improved methods of analysis and interpretation now available or being developed. A critical review of available experience under these improved methods, supplemented by research where needed, should prevail over attempts to average or compromise present practices.

Many angles and details need to be developed in the acquiring of an adequate working knowledge of testing procedure and design for the effective and economical treatment of insulators and insulation for circuits and equipment throughout the system. Actually, it is field experience from efforts to control lightning spillover that has accelerated the necessity of a solution to the insulation co-ordination problem. Under these efforts overhead line insulation levels have outrun or made burdensome equivalent levels for stations and equipment. Especially is this emphasized by relatively recent attempts to utilize the high-impulse insulating value of wood structures in the overhead line.

Based upon the foregoing appraisal of the conditions constituting the problem, I believe the solution will be found in the following direction:

1. Continuation of the survey, laboratory calibration and correlation of the essential electrical performance characteristics of insulators and insulations. Systematic, dependable characteristic data are essential working tools for making analyses and comparisons of field experience.

2. Compilation and analysis of service performance of insulators and insulations as the leading source of data on which to base effective co-ordination.

3. Establishment of basic system insulation levels set above all transient voltages of system internal origin reasonably to be encountered. Lightning surge voltages are excluded from consideration in setting these levels except for those residuals that remain after functioning of the lightning control measures. These basic system levels should be in register with the N.E.L.A.-N.E.M.A. preferred system voltages and, so far as practicable, should constitute a series of steps such as to provide flexible and economical increments. Ratings of these basic levels should be defined in terms of some form of air gap.

4. Segregation of the overhead line for specific treatment quite separate and distinct from that for the stations, the line being the element of the system that encounters initial lightning surges. Some geographic areas experience little or no lightning. It is logical and economical to accept in principle that the harmful element of the lightning surge must be dissipated on the line in the vicinity where it initiates. What specfic measures will prevail for this control of lightning surges cannot be determined yet. There are several proposals of promise. Further development and trial are essential.

Attempts to build the insulation barriers of the line to levels higher than the lightning surge crests, especially in the distribution voltage range, are futile as well as expensive. For the lower voltage lines the solution may be expected with line insulation at or near basic system levels, with some simple provision for freely spilling the lightning surge in the area of initiation, without injury to service or facilities.

For the higher transmission voltages, at least in some general areas, it is practicable and probably economical to avoid lightning spillovers on the line by line insulation set substantially above basic system level, in combination with other measures.

5. The station should be subjected to those surge voltages, only, that are taken into account in establishing the system basic level. This requires that lightning surge voltages positively be limited or reduced to basic level at the line terminal; i.e., at the line entrance to the station. This would be provided by a spill gap of ample discharge capacity set at basic level.

6. To accomplish economical equipment design and to control arc-over damage throughout the station there must be co-ordination of insulation strengths as between line-entrance spillway, station buses and equipment bushings and equipment internal insulation. There would be in the station three voltage levels of insulation:

(a) A *basic system level* coinciding with the level of the spillway gap at the line entrance to the station.

(b) A *bus level* for the buses, connections and equipment bushings, at an increment above basic level.

(c) An *equipment internal* insulation *level* at an increment above bus level. When the equipment bushing has an integral protective gap, the gap would be set at bus level and the bushing proper at an increment above this.

During the interim of effectively working out the foregoing measures there will be need for considered adherence to sturdy insulation margins in line-type transformers, the continuation of multiple lines and other present available means for providing service continuity.

▼

Getting the Economic Life Out of Street Lamps

To avoid burning street lamps longer than their economic life and to make certain that the full economic life of lamps is utilized when they are removed during periodic group changes, one utility company has established the accompanying guides to operation, which of course do not remain fixed, but change with developments in lamps and other factors.

Reports on lamps replaced are turned in each morning, giving the size of the lamp and the reason for replacing it. The slips are used for both periodic and zone changes. They are made out in duplicate for each lamp socket or post, giving the location and wattage of the lamp. The duplicate slips and a list of locations are given to the day men, together with the proper number of lamps to complete the zone. When an old lamp is removed from the socket and a new one substituted the old lamp is placed in the carton with a duplicate of the report. When the zone is completed all the lamps are brought in with the reports accompanying them. While this is being done a clerk in the office computes the number of hours each individual lamp has burned.

When the lamps are brought in the original reports are used to identify the lamps and all lamps that have burned over the allowed number of hours are discarded; others that have not burned their allotted economic life are placed in reserve stock and used as "seconds." The difference in the number of burning hours is brought about by the fact that some of the lamps in the zone are replaced between periodic changes due to breakage, burnout, etc. The "seconds" are used for night replacement of burned-out and broken lamps as long as they last and then new lamps are used.

Number of Hours Which Street Lamps Are Allowed to Burn to Avoid Uneconomic Operation and Minimum Hours of Economic Life Which Must Remain in Removed Lamps to Be Used as "Seconds"

Wattage of Lamps	Allotted Burning Hours	Wattage of Lamps	Hours Life Left, in Seconds
100	1,300	100	1,000
200	1,000	200	700
300	1,350	300	1,000
400	1,250	400	850
500	1,250	500	1,000
750	1,250	750	1,000

▼

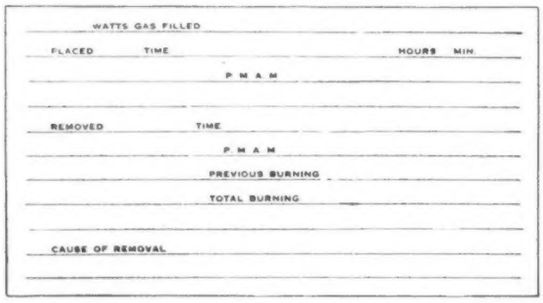
Penstock Costs at Fifteen-Mile Falls

From the field sheets of the New England Power Association engineering organization which built the 156,000-kva. Comerford station on the upper Connecticut River in 1930 are taken the accompanying details of the cost of the four penstocks serving the generating units. The penstocks are 19 ft. in diameter for most of their length of about 150 ft., tapering to 16 ft. at the elbow. Steel plate thickness varied from $\frac{9}{16}$ in. to $\frac{13}{16}$ in. The contract for fabrication, erecting and painting was awarded to the Chicago Bridge & Iron Works Company, Inc., and totaled $99,400. Extra compensation of $4,000 was added on account of construction conditions which developed in the field.

First Cost and Erection

(Cents Omitted)

	Total	Per Kva.
Labor	$2,515	$0.016
Material and Miscellaneous		
Four steel penstocks	99,400	0.635
Testing 732.6 tons of steel at Pittsburg Testing Laboratory	293	.....
Penstock assembling track at factory	188	.....
Inspection of erection	1,361	.....
Lumber	1,159	.....
Structural steel supports for forms	13,141	0.084
Allowance for increased costs to contractor on account of field conditions	4,000	.....
Miscellaneous work done by power company forces for contractor	2,268	.....
Miscellaneous items	3,022	.....
Total of above items	$127,351	$0.816



Nature of report made on each lamp and records kept of each post

LAMP RECORD—STREET LIGHTING

CIRCUIT WATTS | PERIODIC CHANGE LOCATION | CLEANING ROUTE | C. I. DATE / C. I. ORDER / CITY ORDER | TYPE POST / EQUIPMENT | OWNERSHIP

LAMP PLACED	LAMP REMOVED	CAUSE OF REMOVAL	PREVIOUS BURNING	TOTAL BURNING	INSPECTOR	

Public Utility Code Enunciated

By C. W. KELLOGG

President Engineers Public Service Company, New York

Reason for Existence

1. Private ownership and operation of the electric light and power industry is desirable because, and only because, our citizens can in that way obtain the best possible electric service at the lowest reasonable cost.

Equitable Division of Benefits

2. The benefits which result from the operation of this industry will be greatest when there is an honest and understanding co-operation between the owners, the employees and the public. This co-operation cannot continue unless these benefits are proportioned fairly between these three groups. To secure these benefits the industry must so conduct itself as to obtain and hold the sincere confidence of the public and its employees by its performance, ethics and behavior.

Constructive Regulation Essential

3. The interests of the public and the utility both require that the fullest constructive regulation be established, and that destructive regulatory measures be resisted. Full constructive regulation will include furnishing to regulatory bodies complete information regarding every phase of our business, including contractual relations with holding and affiliated companies for financing, management, engineering or for any other purpose.

Employee Relations

4. The employees of the industry should receive fair and adequate compensation. Competent employees should feel reasonably secure of the permanency of their positions, and reasonable provision for sickness and disability should be made. In return, the industry should expect a full measure of their work, ability and loyalty.

Holding Companies

5. To the extent that they are useful in assisting the industry to render the fullest, most reliable electric service at the lowest reasonable cost—through efficient interconnected systems, through the assistance in securing necessary capital most advantageously to the consumer, or through other means—we commend holding companies. We condemn certain abuses practiced by some holding companies and favor regulation to prevent such practices as overcapitalization, subsidiaries loaning funds to holding companies, interloaning of funds between unrelated subsidiaries, improper fees for management, engineering or financing, and the publishing of misleading or withholding of pertinent operating or financial information.

Good Citizenship

6. It is the duty of every electric operating company and its personnel to be good citizens of the communities they serve, giving of their time and resources to non-partisan movements of a general civic nature to and only to the same extent that could reasonably be expected of any good citizen of similar standing and ability.

Politics

7. Public confidence requires that no officer or employee should openly, secretly or in any way exert influence in partisan politics. The attitude of the industry regarding proposed legislation, either favorable or harmful, should be directly and publicly presented by known leaders and officers of the industry to the public, the press and legislative bodies. We condemn the influencing of legislative or public action by propaganda, devious means, or through those indirectly or clandestinely employed.

Valuation

8. We desire to co-operate with those seeking to determine a principle for the valuation of properties upon a basis equitable both to the investors and to the public.

Merchandising

9. The fullest utilization of electric service is beneficial alike to the utility and to the public. That it may be attained, we consider it our duty to demonstrate, instruct in and promote the usage of electrical devices and equipment. Once the use of an electrical device by the public becomes established, however, its sale for profit by the utility, in competition with merchants, dealers and contractors, is no longer a proper function for the utility.

Publicity

10. The public is entitled to frequent, frank and full publicity concerning every phase of our business. In the conduct of its affairs the industry realizes that not only must its practices be above reproach but, in addition, must appear proper, since the appearance of evil is as disastrous of public confidence as wrongdoing.

Presented before the Sales Section, New England Division, N.E.L.A., at Boston, Mass., January 30, 1933

Adjusting Secondary Metering to Include High-Side Losses

By WALTER C. WAGNER
and GEORGE B. SCHLEICHER
Meter Division, Philadelphia Electric Company

A PRACTICAL and economical method of measuring high-tension energy on the low-tension side of a power transformer bank has been developed for a condition where primary metering would be particularly expensive. The method aims to capitalize the resemblance of the characteristic curve of the watt-hour meter and the total loss percentage curve of the power transformer by using the meter adjustments to shift the former into agreement with the latter. Fourteen such secondary installations are in operation on the Philadelphia Electric Company system on station service transformer banks ranging in size from 2,500 kva. to 5,000 kva. Existing secondary meters of standard design were adapted by the method described at a cost of only 10 per cent of the expenditure required for primary installations.

The method will frequently result in considerable economies, since the metering equipment differs in no way from standard metering on the low-tension side. The cost for metering as of the primary side by this method will exceed that of secondary metering only to the extent of the additional time required for the determination of meter-setting points. In general, the greater the ratio between high- and low-tension voltage the greater are the economies effected. Additional advantages of low-tension metering are the greater continuity of service which results from the relative freedom from lightning and other disturbances on the low-tension side and the greater safety to maintenance and meter men due to the entire elimination of high-voltage equipment from the metering installation.

It should be recognized that the method is an approximation. It is limited to installations where the metering measures the entire load of a transformer bank, and in general to transformers which carry load whenever they are energized. The method, however, appears generally suitable for statistical metering, and in cases where the accuracy requirements and load conditions permit may be of value also for billing purposes.

Meters adjusted to include losses of transformers

The method requires a predetermination of transformer losses, such data generally being available from the manufacturer. A brief discussion of transformer losses appears in the caption of Fig. 1.

Modern watt-hour meters provide sufficient range of adjustment to permit their use for the inclusion of power transformer losses, but in some types it may be necessary to change the lag plate. Lag plates of various thicknesses are supplied by meter manufacturers.

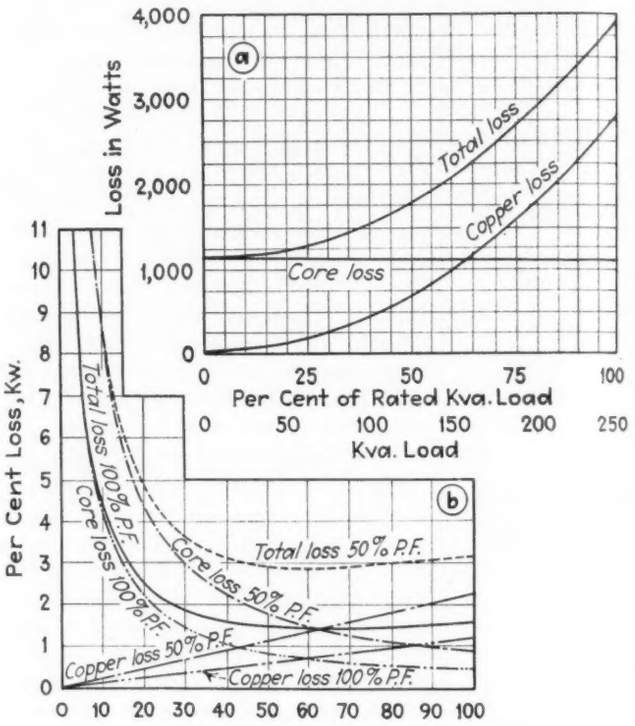


Fig. 1—Percentage losses for a power transformer

(a) Typical core and copper loss curves for a 250-kva., 2,300-115/230-volt power transformer.

(b) Per cent transformer loss for various loads at 50 and 100 per cent power factor. Core loss is approximately constant for given conditions of voltage, frequency and temperature. Copper loss varies as the square of the current and therefore has the straight line characteristic shown as a percentage of secondary output. The combined losses have a characteristic which is inverse to the inherent characteristic of the watt-hour meters shown in Fig. 2. This provides the basis for the method of compensation.

Meter adjustment for the 250-kva. transformer of Fig. 1 when the meter rating equals the transformer rating is shown in Table I. Meter ratings, however, will not generally be the same as that of the power transformer, and since the routine maintenance of the installations will be done by metermen, it is advantageous to determine the points of adjustment in terms of meter rating rather than in terms of transformer rating. Table II shows the required meter settings for such a case, a 250-kva. transformer metered by a 230-volt, 800-amp. meter on the low-tension side. Fig. 3 shows the characteristics of a meter adjusted in accordance with Table II. In practice it is not necessary to plot curves for the entire load range since the meter can be adjusted at only three points. Such curves, however, are of value when it is desired to obtain the best possible results for operation within a limited load range.

When instrument transformer equipment is used many

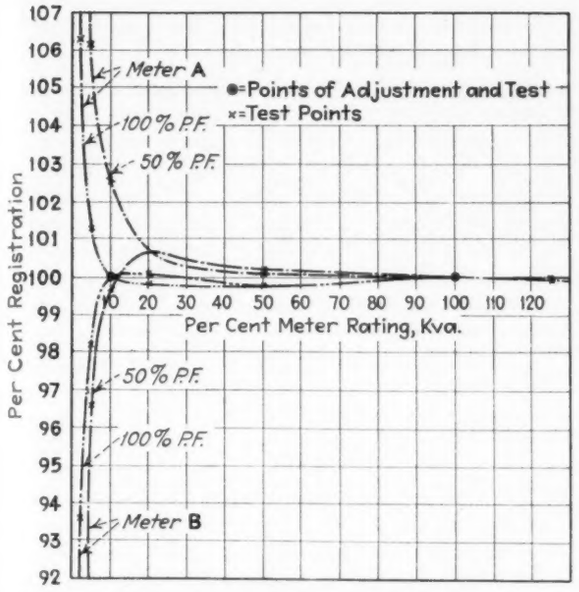


Fig. 2—Meter characteristic resembles transformer loss characteristic

Two types of meters, adjusted to correct for their instrument transformer errors, have the above registration curves for inductive and non-inductive loads.

utilities adjust the meters to correct for the instrument transformer errors at the setting points. Table III shows the required registration of the meter in conjunction with a current transformer of given characteristics.

Accuracy considerations

Service conditions may include variables other than those of load which have already been discussed. Variations in frequency have an effect on transformer losses, but in view of the stability of modern interconnected

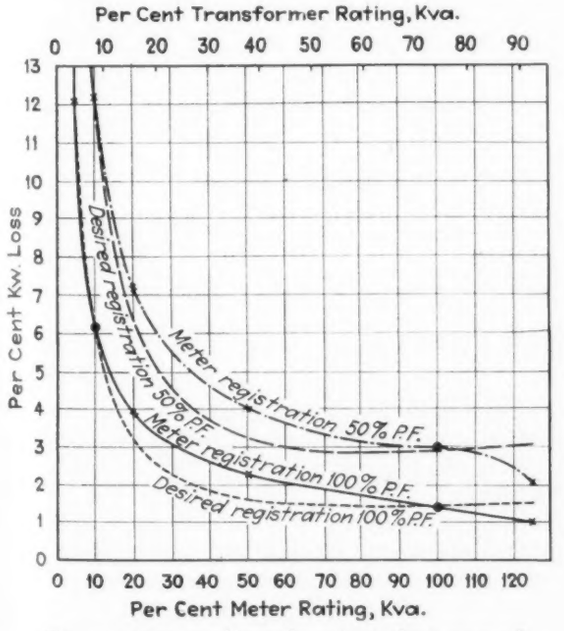

Per Cent Transformer Rating, Kva.
Per Cent Kw Loss
Desired registration 50% P.F.
Meter registration 50% P.F.
Meter registration 100% P.F.
Desired registration 100% P.F.
Per Cent Meter Rating, Kva.

Fig. 3—Meter adjusted to include losses of transformer

Meter characteristic and adjustments suffice to bring registration into close accord with transformer output plus losses. Spread at intermediate loads not large when meter is set to compensate at light load, full load and 50 per cent power factor.

systems this feature is usually of negligible importance. Changes in temperature of the transformer windings result in variations in copper losses, while changes in voltage cause variations in core losses. In the consideration of these variables it must be recognized that the total losses over a period of time will represent a relatively small percentage of the total registration, hence even a relatively large error in the accuracy with which losses are included becomes negligible in terms of total load.

In general, it may be said that with a variation in voltage of ± 10 per cent, with loads from 10 to 100 per cent of the meter rating, the accuracy of registration over a period of time will be within ± 1.0 provided

Meter Adjustment for a 250-Kva. Transformer Under Various Conditions

Table I—Where Meter Rating Equals Transformer Rating

Adjustment	Meter Test Load: Per Cent Kva. Load	Meter Test Load: Per Cent Power Factor	Required Per Cent Meter Registration
Full load	100	100	101.6
Light load	10	100	104.5
Inductive load	100	50	103.1

Table II—With a 230-Volt, 800 Amp. Meter

Adjustment	Meter Test Load: Per Cent Kva. Load on Meter	Meter Test Load: Per Cent Power Factor	Required Per Cent Registration
Full load	100	100	101.4
Light load	10	100	106.1
Inductive load	100	50	102.9

Table III—With a 230-Volt, 800-Amp. Meter, Compensated for Power Transformer Losses and Instrument Transformer Errors

Adjustment	Meter Test Load: Per Cent Kva. Load on Meter	Meter Test Load: Per Cent Power Factor	Instrument Transformer: Per Cent Ratio	Instrument Transformer: Phase Angle* (Minutes)	Combined Correction Factor	Required Per Cent Meter Registration
Full load	100	100	99.9	+ 9	99.9	101.3
Light load	10	100	100.4	+20	100.4	106.5
Inductive load	100	50	99.9	+ 9	99.4	102.3

* Positive phase angles are leading and increase the registration of meters at lagging power factors. Their correction factors therefore are less than 100 per cent for this condition.

that the meters are calibrated at approximately the average operating voltage.

Test results over a several weeks' period on two 250-kva. transformers for which the meters had been calibrated in accordance with Table III are shown in Table IV.

The transformers constitute one of two banks which supply an office building and facilities were available for operating the lighting or power load from either bank.

Operation throughout the test was in general below 50 per cent load on the transformers, and the maximum demand represents about 58 per cent of the transformer rating. The results obtained over a period of time agree substantially with the accuracy characteristic curves as shown in Fig. 4. It is evident also that when the load characteristics are known improved accuracy performance may be obtained by making the adjustments at points within the actual load range. For the installation here considered the best performance would have been obtained by making the full load and inductive load

Table IV—Comparison of Registration of Meters Adjusted to Include Transformer Losses with Primary Kw.-Hr. on a 500-Kva., 2,300-115/230-Volt, Two-Phase Transformer Bank

Elapsed Time (Days)	"A" Phase Pri. Kw.-Hr.	"A" Phase Compensated Sec. Kw.-Hr.	"A" Phase Per Cent Difference	"C" Phase Pri. Kw.-Hr.	"C" Phase Compensated Sec. Kw.-Hr.	"C" Phase Per Cent Difference	Total Pri. Kw.-Hr.	Total Compensated Sec. Kw.-Hr.	Total Per Cent Difference
Lighting Load									
7	6,780	6,781	†0.02	6,160	6,185	†0.41	12,940	12,966	†0.2
14	0	197	*	60	167	*	60	364	*
21	9,020	9,091	†0.79	8,480	8,598	†1.39	17,500	17,689	†1.02
28	10,600	10,667	†0.63	10,100	10,179	†0.78	20,700	20,846	†0.71
35	11,950	11,938	†0.1	11,020	11,094	†0.67	22,970	23,032	†0.27
42	9,910	9,924	†0.14	9,570	9,608	†0.4	19,480	19,532	†0.27
49	8,570	8,611	†0.48	8,300	8,350	†0.6	16,870	16,961	†0.54
56	11,150	11,188	†0.34	9,890	9,903	†0.13	21,040	21,091	†0.24
Total 56 Days.....	67,980	68,397	†0.61	63,580	64,084	†0.8	131,560	132,481	†0.7
Power Load (Approximately 75 per cent power-factor)									
7	2,840	2,866	†0.92	2,690	2,698	†0.30	5,530	5,564	†0.61
14	3,220	3,242	†0.68	3,180	3,181	†0.03	6,400	6,423	†0.36
21	3,000	3,064	†2.14	3,130	3,156	†0.83	6,130	6,220	†1.47
31	7,500	7,599	†1.32	7,820	7,875	†0.70	15,320	15,474	†1.00
36	4,940	4,974	†0.69	5,200	5,235	†0.67	10,140	10,209	†0.67
42	6,430	6,501	†1.10	6,230	6,262	†0.48	12,660	12,763	†0.81
Total 42 days.....	27,930	28,266	†1.20	28,250	28,407	†0.55	56,180	56,673	+0.88
Total combined light and power, 98 days.....	95,910	96,663	†0.78	91,830	92,491	†0.70	187,740	189,154	†0.75

*Transformer bank energized but carrying no load. One primary meter did not register since the load is less than 0.5 per cent of meter rating. Meters adjusted to include transformer losses recorded 4.7 per cent in excess of the calculated core losses for the period.

†Indicates that the registration of compensated meters is greater than that of primary meters.

adjustments at 50 per cent load on the power transformer instead of at the meter rating.

It is interesting to note that for one week of the test the transformers were energized but carried no load. While one of the primary meters did not record under this condition, both compensated meters recorded the core losses (as based on calculations) with a fair degree of accuracy. This will not always occur, however, and the method here described is recommended only when the transformers carry load whenever they are energized, unless test results indicate satisfactory performance under the no-load condition.

Application broadly possible

The method described is suitable for measuring energy as of the high-voltage side of a power transformer bank or to a remote point on the supply lines. It is important, however, that the meters be connected to measure the entire load of one transformer bank, and where a number of banks are operated in parallel a meter should be installed for each bank.

Interchange energy, incoming and outgoing, may be measured in the usual way with ratcheted watt-hour meters, in which case the loss factor would be added to determine the setting points for one meter and subtracted for the other.

Maximum demand as of the primary side may be obtained by applying any of the standard demand devices to the meter.

Any transformer connection may be employed, although with unsymmetrical three-phase connections the per cent copper loss as related to load will be different from that of single-phase connections. For open-delta transformer banks the watts copper loss at full load is 33.3 per cent greater than for a single-phase connection at the same load and load power factor. Similarly the full-load copper loss of the main transformer of a Scott connection is 16.7 per cent greater and of the teaser transformer 7.8 per cent greater than that obtained from single-phase tests on the full winding. For delta-delta, star-star, star-delta, delta-star and two-phase connections single-phase transformer test results may be used directly.

Table V—Summary of Copper Losses at 3,750 Kw. Meter Load, Both Elements Operating at 100 per Cent Power Factor

(468.75 Watts Per Element)

Item	Kw. Loss
Transformers (3)	26.308
Reactors (3)	2.829
Line (3 conductors)	6.936
Total copper loss	36.073

Table VI—Determination of Meter Setting Points

Item	Full-Load (468.75 Watts per Element) 100 Per Cent P.F.	10 Per Cent Load (46.875 Watts per Element) 100 Per Cent P.F.	Inductive Load (234.375 Watts per Element) 50 Per Cent P.F.
For Incoming Energy			
Per cent core loss	0.425	4.25	0.85
Per cent copper loss	0.962	0.096	0.924
Per cent total loss	1.387	4.346	2.774
Required meter registration (per cent)	101.4	104.3	102.8
For Outgoing Energy			
Per cent total loss	1.39	4.35	2.8
Required meter registration (per cent)	98.6	95.7	97.2

Meter-testing methods have an important bearing on the determination and application of the loss factor and due consideration must be given to the testing conditions.

Test loads used for adjusting meters should be exact, particularly for the light-load test. The importance of this is easily evident from the loss characteristic curves, which show that a relatively small variation in light-load current will require a considerable change in accuracy settings.

The meters should be adjusted at approximately the

average voltage of the circuit. On potential transformer installations when resistance loading is used the source of test current should not be from the potential transformers, since the voltage drop so produced will cause the meters to be adjusted at a lower voltage than normal.

As a definite guide for meter calibration a sample calculation is appended. A bank of three 1,250-kva., 14,500-2,300-volt delta-delta connected transformers is metered on the 2,300-volt side with a 1,000-amp. two-element meter. Three 6 per cent reactors are installed in the high-voltage supply lines. The lines have a resistance of 0.0635 ohm per mile. The transformers are not energized unless load is carried. Average operating voltage on the high-tension side is 13,900. It is desired to adjust the existing meters on the low-tension side so as to record energy as of the high-tension side at a point 1.5 miles from the transformer location. Determine the accuracy settings for the meters.

This problem has been selected particularly because it involves practically all complications which may be met in practice, due to the addition of line and reactor losses and the necessity of using a meter installation of considerably higher capacity than the power transformer rating.

Solution—1. The *transformer losses* are obtained for these particular transformers from the test data on file with the manufacturer as follows:

	Transformer		
	A	B	C
	Watts	Watts	Watts
Iron loss (taken at rated voltage).....	5,700	5,800	5,824
Copper loss (full-load at 75 deg. C).....	8,960	8,648	8,700

2. The *reactor losses* are also obtained from the manufacturer, and the reactor data are as follows:
Reactance 6 per cent, 297 amp., 458 volts, 136 kva.
Watt loss at 297 amp. = 3,428

3. *Co-ordination of Copper Losses* — Ordinarily all copper losses (transformer, line and reactor) would be calculated to the basis of the full-load meter current rating (1,000 amp.). In this case, however, the meter rating is considerably in excess of the transformer rating, and since the load never exceeds the latter, it is advantageous to make the full-load adjustment on the meter at or near the full-load rating of the power transformers.

4. Meter load per element for full-load on power transformers =

$$\frac{3{,}750{,}000}{20 \times 200 \times 2} = 468.75 \text{ watts per element}$$

5. Low-tension voltage $= 13{,}900 \times \frac{2{,}300}{14{,}500} = 2{,}205$ volts

6. Total transformer copper loss at full-load =
8,960 + 8,658 + 8,700 = 26,308 watts

7. High-tension current at 3,750 kva. $= \frac{3{,}750}{13.9 \times \sqrt{3}} = 155.8$ amp.

8. Total reactor losses (three reactors) for 3,750-kva. load =

$$\frac{155.8^2}{297^2} \times 3{,}428 \times 3 = 2{,}829 \text{ watts}$$

9. Line loss for three conductors $= 3 I^2 R$
$3 \times 155.8^2 \times (0.0635 \times 1.5) = 6{,}936$ watts

10. *Core loss* at 13,900 volts for three transformers =

$$\frac{13.9^2}{14.5^2} \times (5{,}700 + 5{,}800 + 5{,}824) = 15{,}920 \text{ watts}$$

11. At a full-load secondary meter test load of 468.75 watts per element (937.5 watts total) at unity power factor (equivalent to 3,750 kw. on the power transformers)

$$\text{Core loss} = \frac{15.920}{3{,}750} \times 100 = 0.425 \text{ per cent}$$

$$\text{Copper loss} = \frac{36.073}{3{,}750} \times 100 = 0.962 \text{ per cent}$$

12. Per cent core loss at 10 per cent load (46.875 watts) is ten times the value at full load.

13. Per cent copper loss at 10 per cent load is 0.1 of the full-load value.

14. At full load and 50 per cent power factor (234.375 watts per element) per cent core loss is twice the full-load value = 0.850 per cent and per cent copper loss is also twice the full-load value = 1.926 per cent.

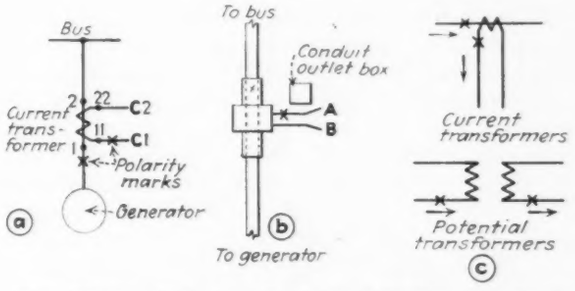
15. In considering outgoing energy the various percentages are added to 100 per cent and for incoming energy they are subtracted from 100 per cent. Table VI summarizes the meter-setting points in accordance with the procedure given in the sample calculation.

▼

Simplifying the Use of Polarity Marks

By G. F. SARGENT and C. H. M. WHITE

Misunderstandings of the significance of current and potential transformer polarity marks handicap construction work and should be eliminated. Frequently transformers already installed in bus structures have been needlessly removed and physically turned around merely to match up with the relative position of polarity marks as shown on wiring diagrams. Such diagrams cause the field man to infer that the marks indicated have a definite



Handling polarity marks in installation drawings
(a) One-line diagram showing current transformer polarity marks; (b) shifting of polarity mark locations in installation; (c) schematic arrangement of polarity marks for use in general note in wiring diagrams.

bearing on relay and metering operation, and for this reason he believes that the drawings should be exactly followed. The shifting of such transformers to agree with such marks often means that secondary connections will be clumsy, nameplates placed upside down or that layouts will be unsymmetrical. In reality, polarity marks are simply a means of telling which secondary lead has the same relative instantaneous polarity as a certain primary terminal. To the field man this is nothing more than an aid to the correct labeling of secondary leads and has nothing to do with the physical position of the transformer.

The simple single-line wiring diagram (*a*) shows a current transformer in a generator lead to the bus, whereas (*b*) shows the actual position of the transformer in the cell structure. The primary polarity mark of the current transformer in place is opposite that shown on the wiring diagram, but to turn the transformer around to make the mark agree with the diagram would bring the secondary leads *A* and *B* on the left-hand side and the conduit ouflet box for the leads on

the right. Actually, no physical shift is necessary, for the polarity marks should merely be used to label the wires. Thus, it follows naturally that lead *A* in (*b*) should be marked C_2 and lead *B* marked C_1 to agree with (*a*). By doing this the electrical connections are made identical. The whole question can be simply handled by omitting the polarity marks from the wiring diagram and putting a general note on each drawing to the effect that, for example, "Current and potential transformers are such that terminals of the same instantaneous polarity are as shown in (*c*)." This means drawing all wiring diagrams so that adjacent primary and secondary leads would have the same instantaneous polarity; e.g., in (*a*) points 2 and 22, 1 and 11, respectively. The removal of the polarity marks to a general note eliminates the physical location problem.

▼

Sees Bigger Field for Storage Battery Locomotives

"If it be possible to build powerful and efficient electric locomotives independent of any connection to an external system, and capable of long journeys without recharging, it is obvious that they would provide a more desirable method of electric traction than that generally adopted at present for main lines." So spoke Miles Walker, president of the British Society for the Advancement of Science, recently, commenting on experiments which the Great Southern Railway is conducting with the Drumm battery under the auspices of the Irish government.

"One can conceive methods of changing batteries so rapidly that no excessive weight need be carried, and the speed between the stops might be so great that a very satisfactory express service could be run. In this connection we must remember the great advantages that can be gained by using some kind of adjustable speed-torque conversion system between the electric motor and the axles. The performance of a locomotive can be enormously improved by the addition of such a system of transmission. This is of especial importance in a battery-driven locomotive, as it does away with complicated control gear and the necessity for high rates of discharge.

"Two very great advantages would result from the adoption of such a locomotive: (1) The changeover from steam to electricity could be made gradually and without requiring any special equipment of the line; (2) in times of war the railway system could be kept running. To make our railways dependent on the continuity of overhead lines is to present such a vulnerable feature to the enemy as almost to invite war." Mr. Walker continued:

"As soon as the characteristics of the battery-driven locomotive are sufficiently good, see what an opening we have in this country for the battery-driven motor car! Instead of thousands of cars burning petrol, costing the nation eighteen millions per annum, and polluting the air of our towns, we would have cars driven by home-generated electricity. Imagine hundreds of battery-charging stations, 20 miles apart along our main roads, at which we could in the course of a few seconds drop our partly discharged battery, and take a new one that would carry us for the next three or four stages. The batteries would probably belong to the Central Electricity Board, and would afford a very nice load for the early hours of the morning."

The best figures yet published on the efficiency per unit weight of the Drumm storage battery, according to Mr. Walker, were about 10 watt-hours per pound of material, but the theoretically possible figures were much higher than 10. Experiments that had been made with light motors for road traction purposes showed that it was possible to reduce the weight by one-half, he contends.

▼ ▼ ▼

Comfort Cooling in Utility Offices

For demonstration to customers and to obtain cost and operating information the Detroit Edison Company installed comfort-cooling equipment in five of its branch offices. Data on these installations were presented by S. S. Sanford at a recent meeting of the Great Lakes Power Club as follows:

Farmer Street Office

Space cooled—57,000 cu.ft.

Method of cooling—Ice with water pumped through fin-tube coils in air duct.

Maximum cooling load—20.7 tons of refrigeration.

Lighting load—18.3 kw.

Hours of operation—8 a.m. to 5 p.m.

Maximum ice consumption for one day in 1932—5 tons.

Ice consumption, July, 1932—119.6 tons.

Ice consumption, August, 1932—116.2 tons.

Average temperatures, U. S. Weather Bureau—July, 72.8 F.; August, 73.0 F.

Size of ice tank—14.5 ft. x 8 ft. x 7.5 ft. deep.

Insulation of ice tank—Two layers of 2-in. corkboard.

General Motors Building Office

Cooled by eight Frigidaire cabinets served by three 3-hp. compressors.

Demand—7 kw.

Consumption:

	Kw.-Hr.
May 10 to July 15	1,360
July 15 to August 16	1,240
August 16 to September 1	760
September 1 to September 15	160
Total May 10 to September 15	3,520

Ann Arbor Office

Space cooled—45,000 cu.ft.

Method of cooling—A 17-ton CO_2 compressor driven by a 25-hp. motor cools a tank of water. The water is pumped through fin-tube coils in the air duct.

Size of water tank—17x3½x5 ft. deep, holding 17,000 lb. of water.

Thermostat in tank stops and starts compressor to keep water temperature between limits of 35 and 40 deg.

Estimated electrical consumption of compressor, pump, agitator and fan—106 kw.-hr.

Port Huron Office

Space cooled—100,000 cu.ft.

Method of cooling—Ice, with water pumped through fin-tube coils in air duct.

Maximum cooling load—17.9 tons of refrigeration.

Lighting load—8.5 kw.

Hours of operation—8 a.m. to 5 p.m.

Ice consumption—July, 1932—80 tons.

Ice consumption—August, 1932—89 tons.

Size of ice tank—17x5x6 ft. 3 in. deep.

Electricity used by fan and pump motors—30 kw.-hr. per day.

Birmingham Office

Under construction.

Method of cooling—Ice, with water pumped through fin-tube coils in air duct.

Hours of operation—8 a.m. to 5 p.m.

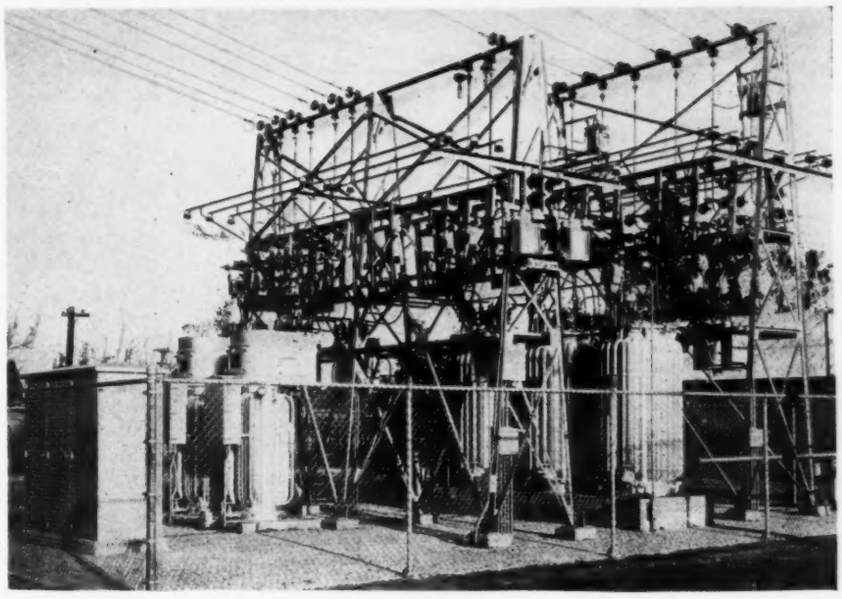
Estimated annual ice consumption—126 tons.

Size of ice tank—16x4x7 ft. deep.

Outdoor Substation Shows Economy

By E. M. SCOTT

Department of Engineering and Construction, Southern California Edison Company Ltd., Los Angeles, Calif.



Consistent with its policy of providing better and more economical service, engineers of the Southern California Edison Company, Ltd., have developed a simple yet flexible type of distribution substation. It was designed chiefly to serve small cities, manufacturing communities and irrigation districts where a capacity of 1,500 kva. to 6,000 kva. is sufficient for the demand. The first installation of this new type has just been completed at Downey, a city near Los Angeles, where increased load made it necessary to replace a substation built in 1914.

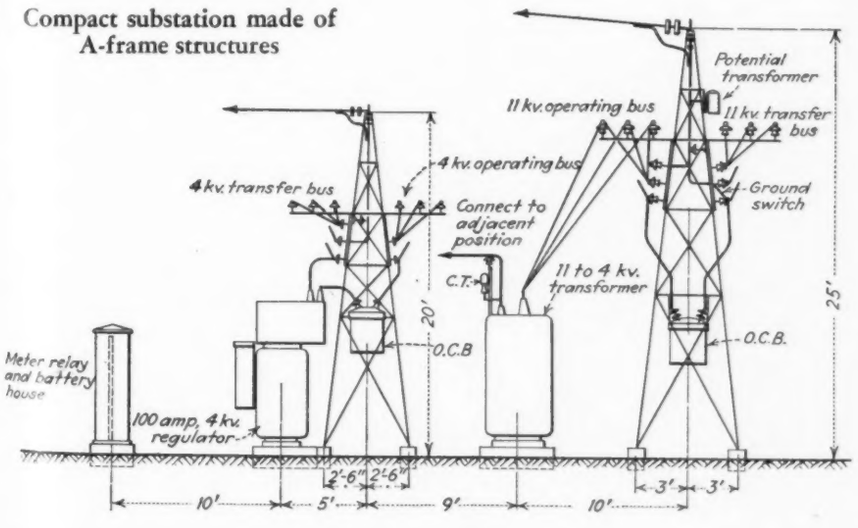
The physical layout consists essentially of "A" frame dead-ends such as are usually constructed for overhead lines. This type of structure serves as a complete unit for the particular voltage on which it is used, whether 16, 11 or 4 kv. The "A" frame as well as being a dead-end structure supports two buses, one oil switch and all disconnecting switches for each circuit. Features of design and construction may be seen from the accompanying illustrations.

The transformer bank is located between two "A" frames, one carrying the high-tension bus and the other the low-tension bus. The induction regulators are placed with their backs close to the 4-kv. "A" frame and under the transfer bus, as shown. The meter and relay board is located in a small metal housing in front and underneath both the 4-kv. and 11-kv. lines.

The 11-kv. operating bus is fed from the incoming lines through the oil circuit breakers, or by by-passing the breakers either the operating bus or the transfer bus may be fed. While the transformer bank is tied solidly to the 11-kv. operating bus, it has a separate position with selector disconnects on the 4-kv. rack. Provision can be made for circuit breakers on each side of the bank, but they are unnecessary when only one bank is used. At present the bank feeds either or both 4-kv. transfer and operating buses through selector switches only. Each pair of 4-kv. "A" frames can take two dead-end positions, for either two lines or a transformer and a line, as required. The line get-away may be either overhead or underground as there is space in the structure between the line-separating screens to allow underground potheads to be installed. If at some later date underground distribution becomes necessary the overhead lines may be eliminated.

The station is served by two 11-kv. lines arranged for either parallel or preferred operation. Normally one line is used as a preferred source. If the preferred line fails change-over to the emergency line is accomplished in 20 cycles. Restoration of service on the preferred line causes its breaker to close immediately, but there is a time delay of 1½ minutes before the emergency line is dropped. The 4-kv. breakers are of the automatic reclosing type and lock out after the second reclosure. At each trip-out an alarm signal is transmitted by telephone line to an attended station. If a breaker locks out a continuous signal is given and a patrolman dispatched to clear the trouble.

Compact substation made of A-frame structures



While outdoor equipment is more expensive for the lower voltages than indoor equipment, yet due to the elimination of a building the cost of a complete station of this type represents a saving of from 14 to 33 per cent, exclusive of land values, over an indoor station of the same capacity. Other advantages include safety from fire hazard, flexibility, extensibility on both ends, short, compact connections, elimination of building and adaptability to both overhead and underground lines.

Scheduling Breaker Inspection Reduces Maintenance Costs

By T. J. ALLEN and W. P. SPEIR
Operating Department,
Atlanta Division, Georgia Power Company

THAT an accurate record of the duty and maintenance of circuit breakers can prove of great benefit through savings effected by a most economical maintenance schedule as well as disclosing faults of equipment and of personnel has been the experience of the Georgia Power Company. The record to date indicates that further economy in maintenance could probably be made safely by lengthening the interval between scheduled inspections of many of the breakers.

Previous to 1928 the maintenance of all oil circuit breakers had been centralized under the general repair superintendent, whose record system provided for allowing the same amount of duty for all breakers before they were inspected or overhauled. After that date the records were transferred to the division personnel; for the Atlanta division this comprised 343 breakers of various ratings and voltages from 2,300 to 110,000. Some of these breakers were of old design and some were practically new. We soon found that we were inspecting some switches unnecessarily and were still having a considerable number of switch failures as well. The duty reports were not coming in soon enough to be of real value. To overcome these faults in the system and in order to distribute our maintenance where it was most needed we made certain changes and began gradually to increase the number of allowable duty cycles or "unit operations," as we have come to call them, on the breakers that experience showed would stand it. On a few of the switches the allowable operations were decreased. In some cases it took two years to arrive at a definite number of unit operations which we felt was the safe limit for the particular breaker in question.

Three forms constitute the record system

In general, our maintenance routine consists of a weekly test to see if the switch is working properly. These tests are made weekly at attended substations and semi-monthly at automatic stations. They are followed up by means of a monthly report to check the regularity of the test. Oil tests are made monthly at transmission stations (66,000 volts and above) and quarterly at distribution stations (stations below 66,000 volts). The results of these tests are sent in to the division office and are recorded. Inspections are made at regular intervals and are divided into three different groups, depending on the reason for the inspection of overhaul. All complete inspections are made under the supervision of the maintenance supervisor, who reports conditions as found and the work done. One person in the division office tabulates and follows up the data on all breakers in the division. This requires about 20 per cent of his time.

OIL CIRCUIT BREAKER NO. 4268

Station EAST POINT TRANSMISSION Service E. Point-Newnan "B" Line Voltage 110 KV
Mfgr. Westinghouse Type S-22 Style No. 80-96-D-953
Amps. 400 Volts 110,000 Serial No. None Gal. Oil per Tank 850
Interrupting Capacity KVA 1,000,000 Operating Mechanism 125 Volt D.C. Solenoid
Bushing Data Dwg. No. B-539726
Duty For Complete Overhaul 10 History

Complete Inspection	Partial Inspection	Duty	Condition	Oil Test	Cost	Complete Inspection	Partial Inspection	Duty	Condition	Oil Test	Cost
6-15-27	–	0	Placed in Service.			–	10-15-30	4	V	24, 25, 25	
6-12-28	–	1	SNF	24, 25, 25 / 25, 25, 25		3-27-31	–	4	SMΦF	23, 24, 25 / 27, 27, 27	
–	2-16-29	3	V	25, 25, 25		–	2-18-31	0	V	27, 27, 27	
–	7-16-29	6	XT	–		–	6-5-31	0	V	27, 25, 25	
–	1-9-30	10	XOF	14 / 25		–	7-9-31	2	V	25, 25, 25	
–	2-11-30	10	V	25, 25, 25		–	9-29-31	3	V	25, 25, 25	
3-20-30	–	10	SCMF	24, 24, 24 / 25, 25, 25		4-19-32	–	5	SΦCF	23, 24, 23 / 25, 25, 25	
–	4-9-30	0	V	25, 25, 25							
–	7-9-30	4	V	25, 25, 25							

(Continued on reverse side)

Fig. 1—Code conserves space on breaker record card

On March 27, 1931, oil circuit breaker No. 4268 was inspected according to the yearly schedule as shown by S. At the time of the inspection it had four unit operations and the maintenance supervisor reported that the mechanism needed adjusting as shown by M, that the oil was carbonized as shown by Φ and was filtered as shown by F. The oil tests before and after the inspection are shown immediately to the right. Other symbols used are: D, inspection after a predetermined duty cycle; X, extra inspection, not necessarily a complete inspection, but sufficient to remove the trouble reported; O, water in the oil; T, oil switch tanks, lining included; C, contacts, current-carrying parts; A, auxiliaries, includes all control circuits; V, oil test; N, inspection not necessary at this time, and B, bushings.

The history of each breaker is kept on a card (Fig. 1), which is a permanent record. This card shows the complete nameplate data, bushing data and a tabulation of all the maintenance required by that breaker, including oil tests. By the use of a code to abbreviate the nature of maintenance the two sides of this card will last eight years for an average switch. The code used on this card merely refers to the type of inspection and that part of the switch that required some kind of maintenance. It does not attempt to detail the work done.

The data for this record are obtained from the oil switch inspection report (Fig. 2) as turned in by the repairmen. During the complete inspection of a breaker the repairmen always tighten loose bolts, dress the contacts or make other slight adjustments that may or may not have been absolutely necessary. Therefore, the repairmen have been requested to make a note on the back of their reports stating whether or not in their opinion the inspection was justified at this time. These reports are filed for two years and then destroyed.

The duty or the unit operations on each breaker are tabulated from day to day in a looseleaf binder where the switches are listed in numerical order according to substation location. The data for this record are obtained from the oil switch operation report (Fig. 3). This form is completed by the substation operator after

any automatic operation and is then forwarded to the division office. With this record, in conjunction with the interruption report showing the location and nature of the trouble, the operation is classified. The opening of a line breaker with normal system set-up and the fault at the mid-point of the line would be considered one unit operation. In case of a fault near the breaker the number of unit operations would be the ratio of the kva. interrupted to the kva. that would be interrupted if the trouble was at the mid-point of the line. No complicated method is used in arriving at the number of unit operations since the person that assigns them is familiar with the system set-up and can approximate them rapidly.

Schedule based on accumulated duty

To give some idea of the extent of this work there were 1,537 automatic operations recorded in 1931. It has been found accurate enough for all practical purposes to consider all automatic line breaker openings, unless the fault was near the station as a unit operation. No attempt is made to classify faults according to phase as too much time would be required to consider every detail of the fault as well as make the record more complicated. Manual operations are not considered unless the switch was opened on overload. Another use of the oil switch operation report is in the analysis of relaying and switching following a major system interruption.

When a switch has received its allowable number of unit operations or has not had a complete inspection for twelve months an order is issued for its inspection. The number of allowable operations varies with the type of breaker and the service to which it is subjected. The ideal schedule would allow a maximum of unit operations and a maximum time between scheduled inspections so that the inspection would always be warranted and still have no switch failures. Of course, such a schedule with all the variables encountered is impossible. The trend toward this ideal furnishes a proof of successful maintenance. This may be seen from a tabulation of our maintenance for the past three years:

	1929	1930	1931
Total inspections	314	416	288
Per cent duty inspections	25.8	17.0	11.8
Per cent scheduled inspections	54.1	62.3	66.4
Per cent extra inspections	20.1	20.7	21.8
Per cent of total inspections where no trouble was found and inspection was apparently unnecessary	32.5	45.0	54.2
Per cent of duty inspections where inspection was found to be unnecessary	26.0	21.1	20.6
Per cent of scheduled inspections where inspection was found to be unnecessary	47.6	66.5	78.1
Switch Failures			
Mechanical (latch and mechanism failures)	4	9	6
Electrical (includes bushings and all insulation)	14	10	6
Control	3	6	11
Total failures	21	25	23

The above data indicate the effect of increasing the unit operations allowed on each breaker (in some cases from 12 to 75) as may be seen by the decrease of duty inspections and increase of scheduled inspections.

Extra inspections have increased slightly. However, an analysis of this type of inspection shows that in 1929 82.5 per cent were listed as miscellaneous, which included failures and considerable work done to improve the condition of the switches. In 1931 the miscellaneous inspections of this type were 36.5 per cent and 63.5 per cent were emergency inspections of oil. This includes the filtering of oil between complete inspections.

The general condition of our equipment shows improvement, as may be seen by the fact that the percentage of total inspections where no trouble was found has increased and at the same time the switch failures have decreased or remained constant.

It will be noted that the per cent of duty inspections where inspections were found to be unnecessary have decreased to 20.6. This apparently is close to the limit to which we can hope to approach the ideal schedule. Scheduled inspections which were found to be unnecessary have, on the contrary, increased from 47 per cent in 1929 to 78 per cent in 1931. To conform to the ideal schedule this trend is in the wrong direction. It indicates, therefore, that further economy in our maintenance could probably be safely made by lengthening the time between the scheduled inspections on many of the breakers. Total breaker failures during the past

OIL CIRCUIT BREAKER INSPECTION REPORT

Station East Point Transmission Switch Number 4268 Service Newnan "South" Line
Volts 110 KV Amperes 400 Manufacturer Whse. Type O-22 30 MVAH No. 961953
Peak Load No Meter Relay Settings 61700 KVA C. T. Ratio 55-1
Main Stop Setting — Tank #1 1/8" Inch. Tank #2 1/8" Inch. Tank #3 1/8" Inch
Toggle Stop Setting — Tank #1 None Inch. Tank #2 None Inch. Tank #3 None Inch
Vent Opening — Tank #1 2" Pipe Inch. Tank #2 2" Pipe Inch. Tank #3 2" Pipe Inch
Counter Reading No counter

Give Condition of the Following as Determined by Careful Inspection:

Main Contacts	OK	Arcing Contacts	OK
Explosion Chambers	None		
Arc Shields	OK	Insulating Tubes	OK
Tank Linings	None	Baffles	None
Operating Rods	OK	Cranks	OK
Clevises	OK	Pins	(See note on reverse side)
Rod Guides	OK	Solenoid Mechanism	OK
Operating Motor	None		
Tanks	OK	Bushings	OK
Auxiliary Switch	OK	Wiring	OK
Closing Relay (1) Arc Chutes	OK	(2) Contacts	OK
Trip Free (1) Mechanical	No	(2) Electrical	No
Levers OK	Arms OK	Pins OK	Lock Nuts OK
Condition of Paint	OK		

Oil Test and Oil Level Before Inspection

Oil Test— Tank #1 22.5 Tank #2 25 KV. Tank #3 25 KV.
Oil Level— Tank #1 OK Tank #2 OK Tank #3 OK
Oil Condition— Tank #1 Carbon KV. Tank #2 Carbon Tank #3 Carbon

Oil Test After Inspection Oil Filtered Yes

Oil Test — Tank #1 27.5 KV. Tank #2 27.5 KV. Tank #3 27.5 KV.

State in detail all repairs and adjustments necessary, on reverse side of sheet.

Inspection Started February 26 19 31 Completed February 27 19 31
Inspected by A.L. Bennett & W.S. Cooley Signed W.J. Brown

Fig. 2—Repairmen turn in report of each inspection

Note on reverse side says: "Pin found sheared off in hand tripping lever. Same repaired. Inspection was necessary at this time."

GEORGIA POWER COMPANY
Oil Switch Operations

Station East Point Transmission Date 6-30-32

Time	O. C. B. No.	Operation	Relay No.	Remarks
AM				
10:41	7168	Auto	4	Lightning
10:41	7178	Auto	1 - 3	"
10:41½	7168	Closed	-	OK
10:42	7178	Closed	-	OK
PM				
12:18	7168	Auto	4	Lightning
12:19	7168	Closed	-	OK
12:20	4384	Auto	3	Lightning
12:20	4398	Auto	21	"
12:21	4384	Closed	-	OK
12:21	4398	Closed	-	OK

Fig. 3—Breaker duty record reported by substation operators

three years remained almost constant. However, a close analysis of the failures shows that in 1929 they caused extensive damage and replacement of parts, while in 1930 the failures were of a minor nature. This system lends itself to the rapid analysis of breaker maintenance from many angles. It must not be concluded that this system of records takes the place of good maintenance because, after all, it is just a record.

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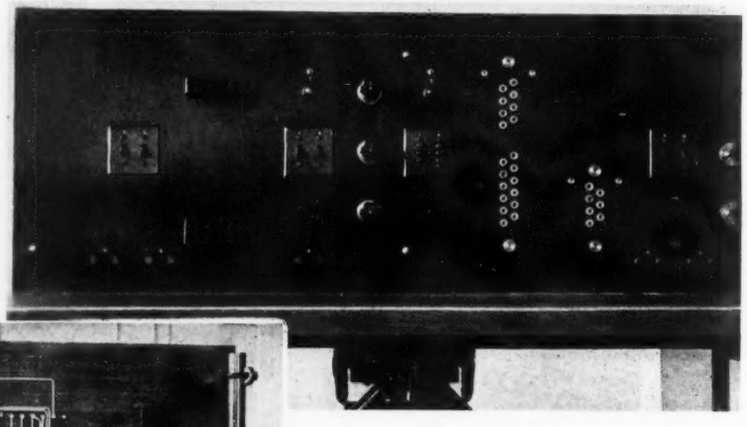
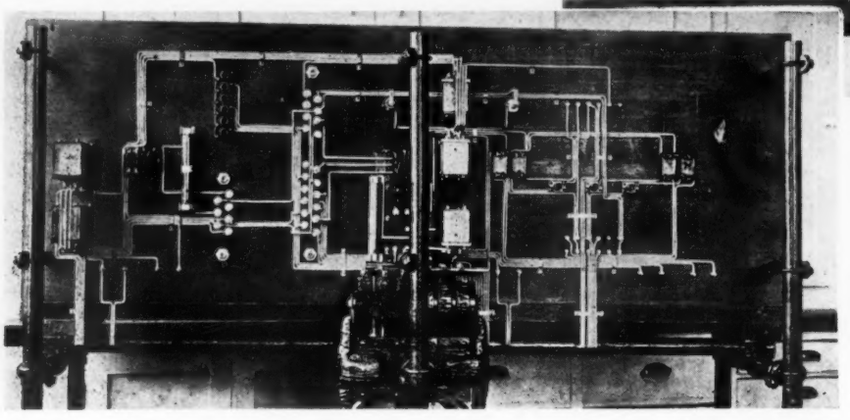
Board Speeds Testing of Network Relays

To minimize space requirements and speed the testing of network relays of General Electric and Westinghouse manufacture the meter department of the Pacific Gas & Electric Company has designed a special test bench and panel. Incorporating the usual loading circuits, a feature of the design is the mounting of the relays under test and the switching connections which can be made rapidly to fit test requirements.

The panel is served from a three-phase, 208/120-volt circuit. Light loads are obtained through rheostats which are connected to binding posts on the front of the panel. An inverted current transformer provides larger currents than can be obtained through the rheostats. Provisions for phantom loads, phase shifting and phasing tests can be set up by proper switching connections. Tests include reclosure, sensitive tripping, non-sensitive tripping and phasing.

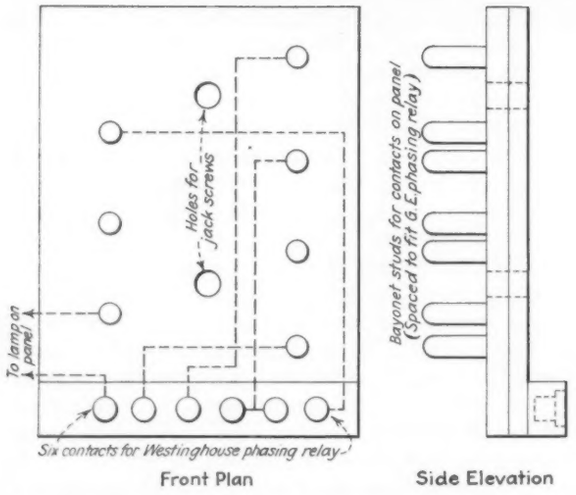
The group of plugs shown on the right of the panel in the accompanying illustration are for General Electric relays, the smaller group on the extreme right being of the phasing relays and larger group adjacent to it for the network relay. These plugs are so arranged as to take the bayonet contacts on the back of the relay which





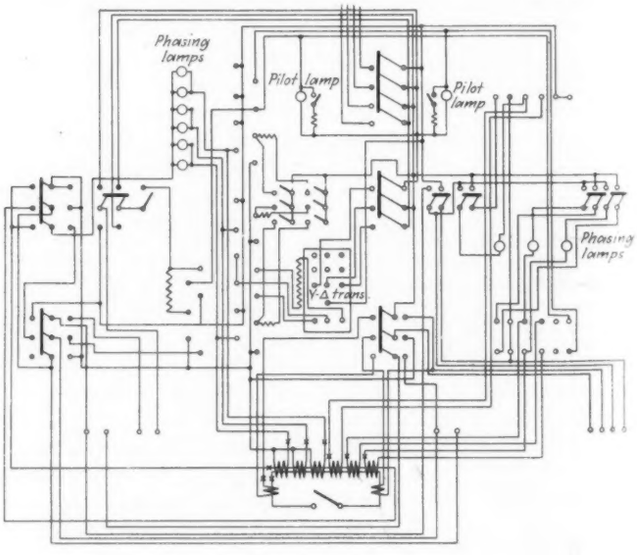
Front and rear views of test panel for network relays

Contacts are arranged so that the relay may be plugged into receptacles on the panel. Rear view shows connections and compact arrangement of the equipment.


Holes for jack screws
To lamp on panel
Six contacts for Westinghouse phasing relay
Bayonet studs for contacts on panel (Spaced to fit G.E. phasing relay)
Front Plan
Side Elevation

Connections for adapter board which transfers connections from plug receptacles to a contact strip suitable for another make of relay

Wiring diagram for the network relay testing panel



is taken from the network protector and inserted on the panel. As the arrangement of the Westinghouse network relay contacts differs from that of the G.E. an adapter board was made up, the connections for which are shown in the accompanying illustration. This board is equipped with studs which fit the contacts on the panel and it is held in place by a jack screw. In effect, the adapter transfers the connections for testing the relay to a contact strip at its base which will accommodate the contacts of the Westinghouse relay.

On the left of the panel are two other contact boards which take the contacts of the Westinghouse network relay. At the base of the panel on the left are three groups of terminals which provide connections for an ammeter and reactors necessary in the test. The two sets of terminals on the extreme right are for rheostats for current control.

All operations are controlled by switches on the front of the panel and the compactness of the equipment, the elimination of duplication for testing relays of the various manufacturers and the provisions for mounting the relays have made it possible to perform tests much more rapidly and with greater accuracy. The panel was constructed by the Pacific Gas & Electric Company and represents a relatively small investment, but one that pays large returns in improved testing methods.

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Excitation Test of Large Transformers a Problem

By L. M. WILLSON

Chief Electrical Inspector Test Department, Pennsylvania Railroad, Altoona, Pa.

Incidental to its extensive electrification program the Pennsylvania Railroad has had to test a large number of 25-cycle transformers of 4,500 to 20,000 kva. rating, including the determination of exciting current and core loss. The fluctuating load on traction transformers renders this an important test. The experience has thrown much light on the problem which distorted wave forms create in the technique of measurement. It has also provided a practical adaptation of the new A.I.E.E. action (Sections 63-88 of the "Preliminary Report on a Proposed Test Code for Transformers," issued in October, 1931).

Obviously the most convenient and accurate way to measure exciting current is to use a test generator that will provide a sine wave of voltage at the terminals of the transformer during the no-load loss and exciting current tests. Root-mean-square ammeters and voltmeters would then involve no special correction for wave form. The difficulty is to provide such a controllable generator supply when testing transformer units of the sizes indicated.

Generators ranging from 1,500 to 30,000 kva. were used for the tests. In some cases the voltage wave was distorted to such an extent that a form factor of 1.26 was obtained, involving appreciable third and fifth harmonics. Under such conditions the use of root-mean-square meters produced exciting current values as much as 40 per cent below what would be obtained with sine wave voltage. The importance of realizing this fact and using some method for obtaining the true value is obvious, especially in cases where transformers are built on a guarantee of a definite maximum exciting current. If the guarantee is on the basis of 110 per cent of normal voltage the distortion of wave form and necessity for making correction are considerably increased.

As a result of this practical experience we have reached certain conclusions which should serve as a guide for the proper measurement of exciting current and core loss of large transformers. These we list in the order of their importance:

First—It is essential to know the wave form or form factor of the voltage applied to the transformer under test during the measurement of the no-load losses. This can be readily accomplished by taking simultaneous readings of voltage, using r.m.s. and "flux" or "average" voltmeters.

Second—Wherever possible a test generator should be used that will provide a sine wave of voltage during the tests. With this condition the two voltmeters will read alike, indicating a form factor of 1.11. Special corrections need not then be made.

Third—Providing a sine wave voltage is not obtainable, and the form factor of the voltage wave varies considerably from 1.11, it is of the utmost importance that the voltage should be set at the value to give the same flux condition as would result from a sine wave of voltage. This can be most readily done by using a "flux" or "average" voltmeter, as prescribed by the A.I.E.E. Standard (No. 13. "Transformers, Induction Regulators and Reactors," issued May, 1930.)

Fourth—If the form factor is very bad it is necessary to use some method for obtaining a correct value of exciting current. The methods suggested in the "Preliminary Report on a Test Code for Transformers" may be used for this further correction.

Finally, in any attempt to obtain accurate results in measuring no-load losses of large transformers it is evident that great care should be exercised by test departments along the lines we have suggested. Our experience has proved that otherwise serious errors cannot be avoided.

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We Have About 44,000,000 Kw.

To get a measure of the total generating capacity in the United States it is necessary to assemble data from several sources. The United States Geological Survey gives yearly statistics on public utility plants, using this term broadly to include railway and other plants serving the public, in addition to those for electric light and power.

Power equipment in manufacturing establishments is reported by the Census Bureau in connection with the Census of Manufactures. The Census of Mines and Quarries is taken at longer intervals. The latest was for the year 1929.

From these several sources the following table has been assembled:

	Kw.
Public utilities (1931)	35,590,072
Manufacturing (1929)	7,793,875
Mines and quarries (1929)	736,347
Total	44,120,294

This appears to take account of all capacity except private plants, as in hotels and amusement parks, on which no statistics are available, but which, from a census report in which they were included but not segregated, may be roughly estimated at 400,000 to 500,000 kw.

READERS' FORUM

Believes Reactive Metering Wholly Satisfactory

To the Editor of the ELECTRICAL WORLD:

Aside from its interesting constructive implications, Mr. Knowlton's article "New Measure of Power Factor," in ELECTRICAL WORLD of January 28, 1933, challenges the accepted concepts centering around power factor. I wish to raise the following points in connection with the article:

1. The facts as I believe them to be accepted are that reactive power (expressed as reactive kva.) is of the nature of *real* power, since it represents physically the maximum rate (expressed in watts or kw.) at which energy is stored in a circuit.

Reactive power is also identical with $\frac{1}{2}\pi$ times the average power of the oscillating energy taken over that quarter of the normal frequency cycle over which the oscillating power is either positive or negative. These interpretations are merely another way of expressing the fact that in the course of one normal frequency cycle the electromagnetic energy $\frac{1}{2} LI^2$ max (neglecting electrostatic energy) is twice stored and twice returned to the circuit, and this is precisely the reason why the corresponding power is not registered on the watt-hour meter. In terms of reactive power, the crest value of stored energy is simply $\left(\frac{I}{2\pi f} \times \text{rkva.}\right)$ kilowatt-seconds, where f is the frequency and rkva. the reactive power.

Reactive power is the algebraic difference between the instantaneous values of total power and the power dissipated in the resistance. The first and the last mentioned quantities being expressed in watts, and the figure being correct beyond all doubt, it follows that the instantaneous values of reactive power represent actual power expressible in watts. The peak of the reactive power wave is identical with the conventional "reactive power."

What I wish to emphasize is the fact that "reactive power" is a physical reality and not merely an economic expedient, even though, for some peculiar reasons, agreement on this fundamental issue has only been reached comparatively recently.

2. Energy which is twice stored in the magnetic field and twice returned during a full cycle does not pass in full through the line to the generators, but appears in part as useful energy in the power-consuming apparatus.

The author of the paper concludes, therefore, that the portion of "reactive power" that is exchanged over the line, and only this portion, which he properly terms "borrowed power," should be used as a basis for power-factor adjustment in power rates, and he proposes an ingenious method for measuring this "borrowed" power. This argument appeals greatly at first sight, but turns out to be fallacious if the question is looked into as to the tax poor power factor imposes upon the power company's plant. It seems that sight was lost of the fact that poor power factor does not only affect the physical size (rating) of generators, transformers and lines, but also causes additional copper losses in the system. It would seem, offhand, that these losses should bear a simple relation to Mr. Knowlton's "borrowed power," but such is not the case, however paradoxical this may sound. If the equivalent resistance of the system from the generator up to the customer's meter is R, and I_a the r.m.s. value of the energy component of the current, I_r the corresponding quadrature component, the energy loss the power company suffers is: $R^a I = RI_a^2 + RI_r^2$. It will be observed that I_r in the second term is directly proportional to the reactive power. From the foregoing equation it is but a step to the important conclusion, first drawn by Boucherot, that the additional losses caused by the connection of a customer's load are directly proportional to both the watt power and the reactive power consumed by this customer. The knowledge of reactive power, and not merely of "borrowed power," is therefore essential for the task of properly charging the customer for this loss.

It is noteworthy, furthermore, that the size, i.e. the rating of power-factor corrective equipment is equal to the difference in the reactive power for the uncorrected and corrected condition. No such simple and obvious connection exists between Mr. Knowlton's "borrowed power" and reactive power, as is evident from the article's Fig. 2.

As far as the fixed charges are concerned, Mr. Knowlton is aware that the concept of power factor is fully adequate, inasmuch as it bears a simple relation to the increase in the rating of plant, and serves, therefore, as a logical and equitable basis for taking care of reactive power as far as it affects demand charge. Consequently no need for a new measure of power factor exists on the score of the fixed charge component of power-factor adjustment.

3. The circuit shown in Fig. 6 in the author's article is adduced as an example of the inadequacy of rkva. metering.

The fact of the matter is that two reactive meters whose series coils are in the two outer wires will correctly measure the reactive loading when added with the proper signs. Since in this extreme circuit the load is purely reactive, "borrowed power" and reactive power become identical and the author's proposed three-element meter and the two reactive meters mentioned would in this particular case yield identical results. The A.I.E.E. definition of polyphase power factor is well suited to cope with conditions as they normally occur in practice. That it cannot be applied indiscriminately to an extreme and very special condition, such as is illustrated in the author's Fig. 6, does not seem to me to be a case in point.

Viewed solely in the light of the above discussion, and apart from all considerations as to practicability from the standpoint of meter construction, it would seem to me to be questionable whether Mr. Knowlton's method,* however ingenious, offers any advantage over present methods of metering of, and charging for, reactive power, and whether it is, therefore, of more than academic interest.

ARTHUR A. BOLSTERLI.
Products Protection Corporation,
New Haven, Conn.

*This scheme, including means for discrimination between leading and lagging power factor, has been patented (1,657,262, January 24, 1928) by Vladimir Karapetoff.—EDITOR.

900-Ton Thrust Bearings for Rhine Turbines

To the Editor of the ELECTRICAL WORLD:

From my article entitled "Kaplan Turbines on Rhine Serve Systems at Three Voltages," which appeared in the ELECTRICAL WORLD of December 17, 1932, it might be presumed that the 900-ton thrust bearings of the Ryburg-Schoerstadt turbines were furnished by Brown Boveri. In fact, they were delivered by the association of the three water-turbine manufacturers who furnished the turbines and built by Ateliers de Charmilles S. A. of Geneva, who constructed and developed them along their own lines.

PAUL R. SIDLER,
New York Representative.
Brown Boveri & Co., Ltd.,
Baden, Switzerland

Men of the Industry

A. A. Betts New President of Utilities Commissioners

Amos A. Betts, chairman of the Arizona Corporation Commission, has succeeded to the presidency of the National Association of Railroad and Utilities Commissioners following the recent resignation of J. Paul Kuhn. Mr. Betts brings to his new executive position a broad background of experience in regulatory work, having served on the Arizona commission continuously since 1917. For fifteen years immediately previous to joining this body he was associated with a number of the large railroads of the country in operating and traffic work. The knowledge he obtained in this connection was exceedingly useful to him when, after the close of the war and the return of the railroads to their owners, he was selected by his associate commissioners to act as a member of many co-operative committees to sit with the Interstate Commerce Commission in proceedings involving state and interstate rates.

In addition to his duties as commissioner, Mr. Betts has been ex officio Insurance Commissioner of the state of Arizona, and at the present time is active in educational circles in Phoenix. He is a member of the American Bar Association.

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E. C. JONES, secretary of the Crocker-Wheeler Electric Manufacturing Company, has been elected a director of that company to fill the vacancy caused by the death of Henry L. Rippe.

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EDWARD P. CONNELL, who has been associated with the Falk Corporation, Milwaukee, continuously since 1913, has been appointed a vice-president of that organization. Mr. Connell was made comptroller of the company in 1924 and this office he will retain.

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FRANK H. GALE, manager of conventions and exhibits of the General Electric Company, has been retired at his request after 43 years of service with the company. L. W. SHUGG has been appointed division manager of the publicity department to succeed Mr. Gale in charge of that work. Mr. Gale will continue as secretary-treasurer of the National Electric Light Association exhibitors' committee and will also have general charge of arrangement for the General Electric Company's participation in the Century of Progress Exposition, Chicago, until it is opened to the public in June. Mr. Shugg entered the employ of the General Electric Company in 1902 and since 1909 has been engaged in the exhibition work of the company. He is director of exhibits for the National Electric Light Association, president of the exhibitors' committee of industrial and power shows, and director of the electrical group of that organization, past-president of the National Railway Appliances Association and was chairman of the exhibits committee of the American Electric Railway Association a few years ago.

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ARTHUR E. KENNELLY, professor emeritus of electrical engineering at Harvard University and the Massachusetts Institute of Technology, was elected president of the Metric Association at the recent annual convention in Atlantic City.

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OSCAR H. FOGG, vice-president of the Consolidated Gas Company and a vice-president of the New York Edison Company, was elected a director of the New York Edison at the recent annual meeting. Mr. Fogg is now a director of ten companies in the Consolidated Gas group.

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HOWARD COOPER, formerly division manager of the Washington Water Power Company at Lewiston, Idaho, has been appointed commercial manager for the Wisconsin Power & Light Company at Madison, Wis. Grover C. Beckman, who has been district manager at Moscow, Idaho, has been named to succeed Mr. Cooper.

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SAMUEL L. NICHOLSON, acting vice-president of the Westinghouse Electric & Manufacturing Company, has been appointed a director of the American Standards Association, on the nomination of the National Electrical Manufacturers' Association, one of the member bodies of the Standards Association. Mr. Nicholson has taken a leading part in the development of national standards in the electrical industry and has represented N.E.M.A. on the A.S.A. Standards Council since 1925.

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W. POOLE DRYER has joined the staff of Arthur L. Nelson Engineers, Boston, Mass., as a specialist in the engineering economies of steam, oil and electric generating plants. Mr. Dryer was formerly prominent in the General Electric Company's engineering organization in connection with steam turbine design and for the past five years has been employed by the Stone & Webster Engineering Corporation in the design of steam turbine stations. He is chairman of the subcommittee on steam-electric station design of the power generation committee of the American Institute of Electrical Engineers.

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GEORGE W. FULLER, consulting engineer of Fuller & McClintock, New York, has been elected chairman of the Engineering Foundation to succeed H. Hobart Porter. Mr. Fuller is nationally known as a hydraulic and sanitary engineer.

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NELSON B. GARDEN has become associated with H. O. Swoboda, Inc., consulting engineers, Pittsburgh. A graduate engineer, Mr. Garden has a wide knowledge of chemistry and metallurgy, as well as experience both in the electrical and mechanical engineering fields. Having been connected with the Swoboda organization in previous years, he is thoroughly familiar with its heating and engineering problems.

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HOWARD COONLEY, president of the Walworth Company, New York, has just been elected president of the American Standards Association to succeed Bancroft Gherardi. The election of Mr. Coonley, who is a director of several industrial, insurance and banking organizations, follows several years of active connection with the stadardization movement.

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HAROLD V. COES, manager of the industrial department of Ford, Bacon & Davis, New York, has been elected president for 1933 of United Engineering Trustees, Inc., joint agency of the four Founder Engineering Societies. Mr. Coes succeeds Harry A. Kidder, superintendent of motive power of the Interborough Rapid Transit Company.

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WILLIAM T. CRAWFORD, secretary of Stone & Webster, Inc., since 1929, was elected a vice-president of that company at a recent meeting of the directors. Mr. Crawford has been associated with the Stone & Webster organization for 25 years and will continue to perform the duties of secretary in addition to the new executive duties which he has just undertaken.

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C. B. BOULET, who is connected with the Wisconsin Public Service Corporation, Milwaukee, has been elected general chairman of the public utilities section of the National Safety Council.

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EARLE S. HENNINGSEN has been appointed engineer in charge of a new department of the Schenectady Works of the General Electric Company, to be known as the motor and generator engineering department. The department will take over all the responsibilities of the former alternating-current and direct-current engineering departments. Mr. Henningsen has been identified with the General Electric organization

since 1912 and for the past three years has served as engineer of the alternating-current engineering department. Other appointments in the new division are J. L. Burnham, designing engineer; I. A. Terry, assistant engineer, and A. P. Wood, consulting mechanical engineer.

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R. H. GARRISON, formerly general sales manager for the Universal Motor Company, Oshkosh, Wis., has become associated with the Marble-Card Electric Company, Gladstone, Mich., manufacturer of electrical machinery, as vice-president in charge of merchandise. Mr. Garrison's earlier training was obtained in the service of the General Electric organization. After this connection he managed a specialty jobbing business, distributed automobiles and later joined the Universal Motor Company.

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OBITUARY

GEORGE L. BAXTER, formerly an electrical engineer with the Fore River Shipbuilding Company, Quincy, Mass., died February 9 at West Dennis, Mass., at the age of 52.

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FRANCESCO MANFREDI, chief engineer of the municipal electricity undertaking in Milan, Italy, and a member of the Italian Electrotechnical Council, died recently in that city in his fifty-first year.

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HENRY A. SINCLAIR, a pioneer in the electrical illumination field, died February 13 at his home in Mystic, Conn., in his seventy-seventh year. A native of Springfield, Mass., Mr. Sinclair spent most of his life in Brooklyn, N. Y. For 39 years he was secretary and treasurer of the Tucker Electric Construction Company of New York. Mr. Sinclair was a fellow of the American Institute of Electrical Engineers and served as treasurer of the New York Electrical Society for 25 years.

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CHARLES V. BARRINGTON, vice-president of Jenkins Brothers, Inc., manufacturer of valves and fittings, died recently, at his home in Bridgeport, Conn., in his seventy-second year. Mr. Barrington was in charge of the Bridgeport plant of the Jenkins company. As a young man he attracted the attention of the late Robert T. Crane, founder of Crane Company. For several years he was established in Russia with offices in Moscow and St. Petersburg, now Leningrad, as special agent for Mr. Crane and the late George Westinghouse. When one of the Crane plants in Bridgeport was acquired by Jenkins Brothers, Mr. Barrington became associated with the Jenkins organization, later being named vice-president.

New Equipment Available

Thermostatic Protection for Appliance Motors

Complete self-protecting motors which cannot burn out and yet carry overloads just as long as the motor itself is not in danger have been announced by the Westinghouse Electric & Manufacturing Company. A small disk type thermostat mounted on the motor frame opens the circuit when the motor gets too hot and connects it again after the motor has cooled. It is suited for automatically controlled devices, such as refrigerators, oil burners, air conditioners, etc.

Because the thermostat is arranged to gage accurately the temperature inside the motor, it lets the motor work as long as possible regardless of service conditions, but removes it from the line when the temperature approaches a damaging value. The thermostat's operation depends upon a combination of the actual motor frame temperature and the line current through the motor. At each load up to the pull-out point of the motor there is a definite length of time required for the motor to reach the temperature which causes the thermostat to open its contacts, removing the motor from the line.

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Tractor-Mounted Arc-Welding Apparatus

Arc-welding apparatus mounted on tractors constructed by the Cleveland Tractor Company, now available for use in remote places, has been announced by the General Electric Company. This equipment is suitable for oil, gas and water line construction and repair work, for repair in construction camps in out-of-the way places, etc.

The unit is simple in construction and has fewer wearing parts than most welding outfits. Instantaneous voltage recovery is accomplished by a transformer reactor, the secondary of which is electrically in series with the main generator field and acts as a voltage booster when a decrease in welding current, caused by breaking the arc, occurs. It is designed for outdoor service.

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BLOWN FROM A SPECIAL NEW GLASS of high silica content, having a minimum of expansion, Pease "Thermex" globes possessing a great resistance to high and rapid changes in temperatures have been announced by the C. F. Pease Company, Chicago. By actual high temperature fire test they show a 400-deg. higher melting point. The globes also have a built-in sturdiness that helps to reduce the percentage of ordinary breakage.

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Instantaneous Unloader for Ammonia Compressors

Development of an instantaneous unloader for synchronous motor-driven ammonia compressors has been announced by the Electric Machinery Manufacturing Company, Minneapolis, Minn. This unloader, in conjunction with automatic control for the motors, makes the by-passing operation of the compressor entirely automatic, dispensing with the need of manual by-passing in starting.

Three important advantages are obtained with the use of automatic compressor unloadings: Automatic start and stop operation of the compressor units can be secured, the compressors starting and stopping by brine thermostats, suction pressure control or other means to maintain desired temperatures; freedom is provided from shut-downs due to power disturbances; power disturbance shut-downs eliminated for momentary voltage dips.

The instantaneous unloader is an automatic pressure-differential-operated by-pass valve connected between the suction and discharge on the compressor. The valve operates by ammonia gas pressure differential and is controlled by magnetic pilot valve, which in turn is controlled by the frequency responsive relay on the synchronous motor-starting panel.

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A SERIES OF SMALL HIGH-TEMPERATURE FURNACES, both box and crucible types, for use up to 2,600 deg. F. and equipped with Globar elements has been brought out by R. G. Hess, New York City. Low initial and maintenance costs, which will have a wide appeal for small laboratories and individuals with limited capital, are claimed for these furnaces.

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FUSE CLIP CLAMP for knife-blade fuses has been added to its line by the Ideal Commutator Dresser Company, Sycamore, Ill. Use of the clamp compels proper alignment and positive contact between the fuse knife blade and the switch fuse block. Undue heating at the fuse connects, which affects the rating of the fuse, is thereby eliminated, preventing premature and frequent blowing of fuses and saving fuse blocks.